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Western Mining in the Twentieth Century Oral History Series

Hedley S. Fowler

MINING ENGINEER IN THE AMERICAS, INDIA, AND AFRICA, 1933-1983

With an Introduction by
Noel W. Kirshenbaum

Interviews Conducted by
Eleanor Swent
in 1990 and 1991

Since 1954 the Regional Oral History Office has been interviewing leading participants in or well-placed witnesses to major events in the development of Northern California, the West, and the Nation. Oral history is a modern research technique involving an interviewee and an informed interviewer in spontaneous conversation. The taped record is transcribed, lightly edited for continuity and clarity, and reviewed by the interviewee. The resulting manuscript is typed in final form, indexed, bound with photographs and illustrative materials, and placed in The Bancroft Library at the University of California, Berkeley, and other research collections for scholarly use. Because it is primary material, oral history is not intended to present the final, verified, or complete narrative of events. It is a spoken account, offered by the interviewee in response to questioning, and as such it is reflective, partisan, deeply involved, and irreplaceable.

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Copy no. 1



Hedley S. "Pete" Fowler, 1983

Cataloging information

Hedley S. Fowler (b. 1911)

Mining engineer

Mining Engineer in the Americas, India, and Africa, 1933-1983, xiii, 122 pp., 1992.

Childhood at Bluebell Mine, British Columbia; education, University of British Columbia and summer jobs as laborer; mining engineer, Cominco [Consolidated Mining and Smelting Co. of Canada], Canada and British Guiana; superintendent, Pacific Lime Co., Texada Island, B.C.; production manager, Denver Equipment Co.; Kaiser Magnesium, Aluminum & Chemical, Engineers, 1951-1961: plant superintendent, California, mine superintendent, Nevada, exploration geologist, Florida, Hawaii, project engineer, India, Ghana, chief engineer, Mountain Copper Co. 1961-1968; discusses development of syllabus and examination to register mining engineers, National Council of Engineering Examiners, 1974-1982.

Introduction by Noel Kirshenbaum, manager of mineral projects development, Placer U.S. Inc.

Interviewed in 1990 and 1991 by Eleanor Swent for Western Mining in the Twentieth Century series. The Regional Oral History Office, The Bancroft Library, University of California, Berkeley.

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PREFACE

The oral history series on Western Mining in the Twentieth Century documents the lives of leaders in mining, metallurgy, geology, education in the earth and materials sciences, mining law, and the pertinent government bodies. The field includes metal, non-metal, and industrial minerals, but not petroleum.

Mining has changed greatly in this century: in the technology and technical education; in the organization of corporations; in the perception of the national strategic importance of minerals; in the labor movement; and in consideration of health and environmental effects of mining.

The idea of an oral history series to document these developments in twentieth century mining had been on the drawing board of the Regional Oral History Office for more than twenty years. The project finally got underway on January 25, 1986, when Mrs. Willa Baum, Mr. and Mrs. Philip Bradley, Professor and Mrs. Douglas Fuerstenau, Mr. and Mrs. Clifford Heimbucher, Mrs. Donald McLaughlin, and Mr. and Mrs. Langan Swent met at the Swent home to plan the project, and Professor Fuerstenau agreed to serve as Principal Investigator.

An advisory committee was selected which included representatives from the materials science and mineral engineering faculty and a professor of history of science at the University of California at Berkeley; a professor emeritus of history from the California Institute of Technology; and executives of mining companies.

We note with much regret the death of two members of the original advisory committee, both of whom were very much interested in the project. Rodman Paul, Professor Emeritus of History, California Institute of Technology, sent a hand-written note of encouragement just a few weeks before his death from cancer. Charles Meyer, Professor Emeritus of Geology, University of California at Berkeley, was not only an advisor but was also on the list of people to be interviewed, because of the significance of his recognition of the importance of plate tectonics in the genesis of copper deposits. His death in 1987 ended both roles.

Thanks are due to other members of the advisory committee who have helped in selecting interviewees, suggesting research topics, and raising funds.

Unfortunately, by the time the project was organized several of the original list of interviewees were no longer available and others were in failing health; therefore, arrangements for interviews were begun even without established funding.

The project was presented to the San Francisco section of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME) on "Old-timers Night," March 10, 1986, when Philip Read Bradley, Jr., was the speaker. This section and the Southern California section provided initial funding and organizational sponsorship.

The Northern and Southern California sections of the Woman's Auxiliary to the AIME (WAAIME), the California Mining Association, and the Mining and Metallurgical Society of America (MMSA) were early supporters. Several alumni of the University of California College of Engineering donated in response to a letter from Professor James Evans, the chairman of the Department of Materials Science and Mineral Engineering. Other individual and corporate donors are listed in the volumes. The project is ongoing, and funds continue to be sought.

Some members of the AIME, WAAIME, and MMSA have been particularly helpful: Ray Beebe, Katherine Bradley, Henry Colen, Ward Downey, David Huggins, John Kiely, Noel Kirshenbaum, and Cole McFarland.

The first five interviewees were all born in 1904 or earlier. Horace Albright, mining lawyer and president of United States Potash Company, was ninety-six years old when interviewed. Although brief, this interview will add another dimension to the many publications about a man known primarily as a conservationist.

James Boyd was director of the industry division of the military government of Germany after World War II, director of the U.S. Bureau of Mines, dean of the Colorado School of Mines, vice president of Kennecott Copper Corporation, president of Copper Range, and executive director of the National Commission on Materials Policy. He had reviewed the transcript of his lengthy oral history just before his death in November, 1987. In 1990, he was inducted into the National Mining Hall of Fame, Leadville, Colorado.

Philip Bradley, Jr., mining engineer, was a member of the California Mining Board for thirty-two years, most of them as chairman. He also founded the parent organization of the California Mining Association, as well as the Western Governors Mining Advisory Council. His uncle, Frederick Worthen Bradley, who figures in the oral history, was in the first group inducted into the National Mining Hall of Fame, Leadville, Colorado, in 1988.

Frank McQuiston, metallurgist, vice president of Newmont Mining Corporation, died before his oral history was complete; thirteen hours of taped interviews with him were supplemented by three hours with his friend and associate, Robert Shoemaker.

Gordon Oakeshott, geologist, was president of the National Association of Geology Teachers and chief of the California Division of Mines and Geology.

These oral histories establish the framework for the series; subsequent oral histories amplify the basic themes.

Future researchers will turn to these oral histories to learn how decisions were made which led to changes in mining engineering education, corporate structures, and technology, as well as public policy regarding minerals. In addition, the interviews stimulate the deposit, by interviewees and others, of a number of documents, photographs, memoirs, and other materials related to twentieth century mining in the West. This collection is being added to The Bancroft Library's extensive holdings.

The Regional Oral History Office is under the direction of Willa Baum, division head, and under the administrative direction of The Bancroft Library.

Interviews were conducted by Malca Chall and Eleanor Swent.

Willa K. Baum, Division Head
Regional Oral History Office

Eleanor Swent, Project Director
Western Mining in the Twentieth
Century Series

October 1990
Regional Oral History Office
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Western Mining in the Twentieth Century Oral History Series
Interviews Completed, August 1992

Horace Albright, Mining Lawyer and Executive, U.S. Potash Company, U.S. Borax, 1933-1962, 1989

James Boyd, Minerals and Critical Materials Management: Military and Government Administrator and Mining Executive, 1941-1987, 1988

Philip Read Bradley, Jr., A Mining Engineer in Alaska, Canada, the Western United States, Latin America, and Southeast Asia, 1988

Catherine C. Campbell, Ian and Catherine Campbell, Geologists: Teaching, Government Service, Editing, 1989

James T. Curry, Sr., Metallurgist for Empire Star Mine and Newmont Exploration, 1932-1955; Plant Manager for Calaveras Cement Company, 1956-1975, 1990

J. Ward Downey, Mining and Construction Engineer, Industrial Management Consultant, 1936 to the 1990s, 1992

Hedley S. "Pete" Fowler, Mining Engineer in the Americas, India, and Africa, 1933-1983, 1992

James Mack Gerstley, Executive, U.S. Borax and Chemical Corporation; Trustee, Pomona College; Civic Leader, San Francisco Asian Art Museum, 1991

John F. Havard, Mining Engineer and Executive, 1935-1981, 1992

George Heikes, Mining Geologist on Four Continents, 1924-1974, 1992

Helen R. Henshaw, Recollections of Life with Paul Henshaw: Latin America, Homestake Mining Company, 1988

Lewis L. Huelsdonk, Manager of Gold and Chrome Mines, Spokesman for Gold Mining, 1935-1974, 1988

Arthur I. Johnson, Mining and Metallurgical Engineer in the Black Hills: Pegmatites and Rare Minerals, 1922 to the 1990s, 1990

Evan Just, Geologist: Engineering and Mining Journal, Marshall Plan, Cyprus Mines Corporation, and Stanford University, 1922-1980, 1989

Plato Malozemoff, A Life in Mining: Siberia to Chairman of Newmont Mining Corporation, 1909-1985, 1990

James and Malcolm McPherson, Brothers in Mining, 1992

Frank Woods McQuiston, Jr., Metallurgist for Newmont Mining Corporation and U.S. Atomic Energy Commission, 1934-1982, 1989

Gordon B. Oakeshott, The California Division of Mines and Geology, 1948-1974, 1988

Vincent D. Perry, A Half Century as Mining and Exploration Geologist with the Anaconda Company, 1991

Carl Randolph, Research Manager to President, United States Borax and Chemical Corporation, 1957-1986, 1992

James V. Thompson, Mining and Metallurgical Engineer: the Philippine Islands: Dorr, Humphreys, Kaiser Engineers Companies: 1940-1990s, 1992

Interviews In Process

Samuel S. Arentz, Jr. (Escalante Mine), in process

Donald Dickey (Oriental Mine), in process

Wayne Hazen (metallurgy), in process

James Jensen (metallurgy), in process

John Livermore (geologist), in process

John Reed (rock mechanics), in process

Joseph Rosenblatt (EIMCO), in process

Eugene Smith (U.S. Borax), in process

Langan Swent (San Luis, Homestake, uranium mining), in process

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The Regional Oral History Office
would like to express its thanks to the organizations
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INTRODUCTION--by Noel W. Kirshenbaum

Most often when a biography is written it is of a person whose career has made history; the individual may have founded or headed a major enterprise or, in the case of the minerals industry, may have been fortunate enough to have made significant mineral discoveries (or, having been even luckier or more persevering, may have achieved great success on the basis of someone else's mineral discovery). On occasion, an inventor of a process or technology has been the subject of biographical treatment. Whether written as biographies or taken as oral histories, these accounts are valuable documents for recording and transmitting history to future generations.

What is less common is the biographical record of a person who possesses many years of knowledge and experience across a breadth of activities--but whose career may not have featured a leadership role in a single enterprise nor a momentous discovery or invention. Nonetheless, the insight provided by such a person can greatly enhance and deepen the view of an industry.

In my opinion, Pete Fowler's oral history is the type of record that can help "fit the pieces together" for a posterity that will only be able to discern the condition of the minerals industry in the twentieth century from review of such documentation. His record spans a long and still active career which extends across many, if not most, components of the mining, metallurgical, and associated sectors. It may not be known to many of his acquaintances that his broad professional experience embraces the ferrous, base metal, aluminum, non-metallic, and by-product areas of the industry, as well as service and vendor firms and construction and civil projects. Moreover, in these various pursuits, his career has included activities in a number of countries.

In these days when so many professionals, be they medical doctors or geologists, have become narrow specialists, the insight and perspective of one whose career cuts across a variety of disciplines should be well appreciated; there are so many inter-dependencies amongst the various sciences and branches of commerce.

A recent publication of The Bancroft Library's Regional Oral History Office contained a headline proclaiming, "Telling it like it was, To change what might be." This heading reminded me of some of Pete Fowler's observations on managerial and professional practices which he has seen evolve for the better over the years. Future readers will use his assessments and those of others as benchmarks against which they will judge future changes, to form a panorama of the continuing evolution of

the minerals industry in an era in which the relationship between the industrial sector and society at large has been undergoing radical if not revolutionary change--from adversarial to partnership roles, from environmental indifference towards enlightened stewardship.

Noel W. Kirshenbaum
Placer Dome U.S. Inc.

October 1992
San Francisco, California

INTERVIEW HISTORY--Hedley S. "Pete" Fowler

Hedley S. "Pete" Fowler was selected for participation in the oral history series on Western Mining in the Twentieth Century as a representative mining engineer of his time. His father, Samuel S. Fowler, graduated from the Columbia School of Mines more than a century ago, in 1884, and was general manager of the Bluebell Mine in British Columbia, where the son Pete grew up, committed to a mining career almost from birth. He has worked on four continents for a number of companies, and expresses pride and satisfaction in his profession. He is a Legion of Honor member of the Society for Mining, Metallurgy, and Exploration [SME] of the American Institute of Mining, Metallurgical, and Petroleum Engineers [AIME], and has been chairman of the San Francisco section of AIME, and of the San Francisco Section of the Mining and Metallurgical Society of America [MMSA].

Pete Fowler's oral history tells of an idyllic boyhood, when he swam in ice-cold Kootenay Lake all summer, and commuted by bicycle and steamboat to high school. He graduated from the University of British Columbia in 1933 as a mining engineer, and is still registered as an engineer in that province, although he has always been a citizen of the United States.

He worked first for the Canadian company Cominco in a variety of jobs, as surveyor, laborer, millman, and mining engineer. He met his wife Kay on a steamer going to Alaska. She was a music teacher at Stephens College in Missouri, and worked during vacations as violinist aboard cruise ships. They courted in British Guiana where Pete was working at a bauxite prospect and Kay's Caribbean cruise ship stopped over.

After a time as manager of a lime plant on Texada Island, British Columbia, Mr. Fowler came to Denver as plant engineer for Denver Equipment Company, run by its founder, A.C. Daman. From there he went to Oakland, California, in 1951 to work for Kaiser companies--Kaiser Aluminum & Chemical, Kaiser Magnesium, Kaiser Engineers--in a variety of engineering jobs. He was superintendent of a magnesium processing plant in California and a fluorspar mine in Nevada. He explored for aluminum in Florida, Hawaii, and India; he was site investigation engineer for the Volta Dam in Ghana. Subsequently he worked for Mountain Copper Company as chief engineer.

Mr. Fowler also discusses the rationale for licensing of engineers and tells of the considerable time and effort he gave to developing the National Council of Engineering Examiners test for qualifying and licensing mining engineers.

A letter inviting Mr. Fowler to be interviewed was sent on 9 November 1990; the interviews were held on 29 March and 2 and 3 April 1991 in his home high in the hills of Oakland, California, overlooking San Francisco Bay. Mr. Fowler was well prepared for the interview and provided detailed information from his files. When the transcript was sent to him for review, he made a few changes and returned it promptly.

The introduction to the Fowler oral history was written by Noel Kirshenbaum, manager of mineral products development, Placer U.S. Inc., a fellow member of the SME and AIME.

The tapes of the interviews are available for study at The Bancroft Library, University of California at Berkeley.

Eleanor Swent, Project Director
Western Mining in the Twentieth
Century series

July 1992
Regional Oral History Office
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University of California, Berkeley

BIOGRAPHICAL INFORMATION

(Please write clearly. Use black ink.)

Your full name Hedley Stewart (Pete) FOWLER

Date of birth June 18 1911 Birthplace Nelson, B.C.

Father's full name Samuel Stewart Fowler

Occupation Mining Engineer Birthplace New York N.Y.

Mother's full name Frances Elizabeth Hedley

Occupation House W. Community Leader Birthplace Halifax N.S.

Your spouse Catherine Moore (Violin Teacher)

Your children Kenneth Stewart Fowler (Seattle Wn. Now)
Helen Frances Neville (Oakland CA. Now)

Where did you grow up? Riondel, on Kootenay Lake, B.C.

Present community Montclair, Oakland CA.

Education BA Sc. Min. Eng. U of British Columbia, Vancouver (1933)

Occupation(s) Mining Engineer; Gen Supt. Lime, Fluorspar; Explor. Ugr-

Bauxite Hawaii, India; Chief Site Investigator Dam-Ghana; Chief Eng - Dir. Re-

Consulting Engineer.

Areas of expertise Broad concepts of
mineral industry, evaluation of mineral
projects.

Other interests or activities Skiing, walking 12 mi per week.

Church head usher 1 day/month. Support Parents and Friends
of Lesbians & Gays (a much misunderstood part of society) gardening
photos.

Organizations in which you are active Canadian Inst of Mining & Metallurgy.

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I EARLY YEARS, 1911-1933

[Interview 1: March 29, 1991]##¹

A Happy Childhood at Riandel, a Mining Camp in British Columbia

Swent: Let's begin by asking you to tell us where and when you were born.

Fowler: I was born in June, 1911, in Nelson, which was a mining town in British Columbia, and also a lumber town, on the west arm of Kootenay Lake. My parents lived on the main lake on the east side, right where that picture is [points to a picture], practically on the edge of it there. That was about thirty miles from Nelson. My dad [Samuel Stewart Fowler] was at the time the manager of the Bluebell Mine, which was owned by the Canadian Metal Company in Paris. They operated it for quite some time.

So I grew up in a mining camp and I never gave serious thought to being anything but a mining engineer. It's been really a very enjoyable life.

Swent: You're always known as Pete.

Fowler: That's correct.

Mother's Family, the Hedleys, and the Hedley Mine

Swent: It's a well-known secret that your name is really Hedley.

Fowler: Yes.

¹This symbol (##) indicates that a tape or a segment of a tape has begun or ended. For a guide to the tapes see page 115.

Swent: Do you have a connection with the Hedley Mine?

Fowler: It's a very remote connection. I can tell you fairly quickly what it was. My mother was a Hedley and her brother Rob was a very well-known mining engineer in B.C. at the turn of the century. He grub-staked a prospector who was looking around in the vicinity of Hedley and he staked a claim and then another prospector staked a claim known as the Nickel Plate which became a well-known mine, with quite substantial production over a number of years.

Anyway, I think Peter Scott was the prospector and he evidently did reasonably well. So he caused the name of Hedley to be given to the town that grew up there. It was a prosperous town for quite a few years early in the century. It's just a village now.

Incidentally, I went back there last summer with several of my relatives to have a little Hedley reunion. We had about thirty people at it, so that was kind of fun. They came from places including Florida; San Diego; Seattle; Vancouver; Victoria; Montreal; Timmins; Ontario; 100-Mile House, B.C.

Swent: These mines around Hedley were all gold mines, were they?

Fowler: Yes, in spite of the name of Nickel Plate.

Swent: So growing up in Nelson--.

Fowler: Well, I didn't grow up in Nelson. I grew up at the Bluebell Mine. Incidentally, my dad established a post office there and he wanted to call the post office Bluebell, but the authorities wouldn't allow it because there was a place called Bluebell somewhere in Quebec. So he called it Riondel after the president of the French company that owned the place. A very interesting little thing in connection with that, or two interesting things: one was that when Dad first went there, he established a rule that no game should be killed and no timber cut on the property without his personal permission. It has remained to this day one of the beauty spots in British Columbia. The mine is now worked out. It's a retirement community now, largely of the last people who worked there about 1970.

Father, Samuel S. Fowler, Mining Engineer and Mine Manager

Swent: Where had your father gone there from?

Fowler: He was formerly the manager of London and British Columbia Gold Fields, which had several properties and a couple of power plants in British Columbia. They were very small power plants by today's standards but they were hydro. The Ymir Mine near Nelson had been the principal mine there and that did quite well for a number of years. Then, previous to that, Dad was in a lot of places. He first went to British Columbia in 1890. From 1900 to 1901 he was the second president of the Canadian Institute of Mining (later Mining, Metallurgy and Petroleum but still CIM).

Swent: How had he received his training in mining?

Fowler: He had an A.B. degree from Columbia in 1881 and an Engineer of Mines in 1884.

Swent: Was he an American?

Fowler: Yes. He remained an American until 1922. Then he took out his Canadian papers.

Swent: Columbia, of course, was the granddaddy of mining schools, wasn't it?

Fowler: Yes, it was. I remember as a boy for a little while thinking I would like to go to Columbia, but financially that was completely out of the question.

Swent: A long ways away.

Riondel, Remote but not Isolated

Fowler: The other thing I was going to say about Riondel. There was no road access until 1933, but in all of my life prior to that we had mail service twice a day, six days a week. We got letters from London sometimes in about a week. They came on the Canadian Pacific Trans-Atlantic into Halifax and across the continent on the Canadian Pacific Railway. It was good service.

Swent: There was a railway stop in Riondel?

Fowler: No. There was no road access at all, but the lake steamers--.

Swent: That's what connected you to the world, then.

Fowler: Yes.

Swent: Twice-a-day mail.

Fowler: You see, it went south in the morning to Nelson from Kaslo and in the evening it went back to Kaslo again. So we got mail from both Kaslo and Nelson.

Swent: Was there a school there at the Bluebell?

Fowler: Yes, but I think the most students who were ever there was about twelve, at least in my boyhood anyway.

Swent: One teacher?

Fowler: One teacher, yes. I don't feel I suffered at all from it.

Swent: Obviously, you didn't, no. You must have felt very special as the manager's son.

Fowler: Well, I guess a bit, but I think one of the important things there was that we learned that the kids were all alike. Certainly, we had some privileges, but I'm sure that my dad saw to it that we didn't take advantage of it.

Swent: Had his family been in mining before his time?

Fowler: No. His father was an organ builder in New York; I think just small organs. But I never saw him. Dad's mother was still alive when I was born, but I can't remember her. I can remember my mother's mother. Dad's mother was quite a small person and Mother's was the other way, so it was Big Granny and Little Granny.

Swent: Was your mother's family American or Canadian?

Fowler: The family, four boys and four girls, grew up in Halifax, Nova Scotia.

Swent: Did you travel to Eastern Canada or to England at all?

Fowler: No. After I was born, I think Dad went back to Paris once and took Mother with him. Then he was back again at least once, in the late 1920s. That time he went alone. I remember he thought it was quite an experience. He flew from London to Paris.

Swent: That was an early, early flight.

Fowler: That was about 1927.

Swent: Right after Lindbergh. Did you have visitors from France and England?

From CIM Bulletin
(Canadian Institute of
Mining, Metallurgy and
Petroleum), March 1992

CIM's oldest membership pin finds a home at the Institute



Among the many interesting pieces of memorabilia in the CIM offices in Montreal is the oldest known membership pin, which once belonged to S.S. Fowler, President of the Institute from 1900 to 1901. The pin, mounted on a mahogany stand, bears the scars of years of wear and tear. The original design, bearing the name, "Canadian Mining Institute"—the change to

"Mining and Metallurgy" was two decades away—is a reminder of the rich history of the Institute.

The pin was donated to the Institute by his son, H.S. Pete Fowler of Oakland, California. In thanking him for what he refers to as this "priceless memento", CIM Executive Director Pierre Michaud says that "this expression of a direct link to CIM's rich past has been given the place of honour on my working desk where it has been admired by visitors to my office."

Meanwhile, the new CIM pin, bearing the newly-designed logo, will soon be available to members. If you are interested in purchasing one of these beautiful, 14-karat gold pins, please write or call Andrew Caddell, director of Public Affairs, CIM, Suite 1210, 3400 de Maisonneuve Blvd. West, Montreal, Quebec, H3Z 3B8. Among the first people to receive the new pin will be H.S. Pete Fowler, in gratitude for his generosity, and also to replace his father's pin.

SAMUEL STEWART FOWLER.

Samuel Stewart Fowler, one of the foremost mining engineers of Columbia, a resident of the city of Nelson, and active in the management and development of several of the most important mining, power and industrial enterprises of this section of the province, was born in New York city in 1860. His parents were Azro and Louisa (Abbott) Fowler, of well known and long established New England ancestry.

Mr. Fowler received the highest educational advantages offered in the eastern metropolis. He graduated from a liberal arts course in 1881 with the degree of A. B., and in 1884 graduated from the Columbia University School of Mines with the degree of E. M. From 1884 to 1886 he was employed as a civil engineer in New York. In May, 1886, he went to the Black Hills of South Dakota, and filled positions in mining, smelting and milling concerns. In January, 1888, he was called to El Paso, Texas, and there built and operated a smelting plant. In the fall of 1888 he became assistant superintendent of the Bunker Hill and Sullivan mines of Idaho. In the summer of 1889 he arrived in British Columbia, this being a preliminary trip with reference to the building of a smelter for western capital. In 1890 he built, at Golden, one of the first smelters in the province. From 1891 to 1896 he was mining engineer for several British syndicates and at the same time prospected in different portions of the province.

In the spring of 1896 Mr. Fowler became engineer for the London and British Columbia Gold Fields Company, a finance and development syndicate, which organized the Ymir Gold Mines, Limited, the Whitewater Gold Mines, Limited, and the Enterprise British Columbia Mines, Limited. This company took over the property of the Cascade Water Power and Light Company, and equipped and utilized the power of the falls of the Kettle river at Cascade City, the plant now supplying power to the surrounding districts. Since the death of J. Roderick Robertson Mr. Fowler has assumed the management of the company's interests, and has lent his energies and ability without reserve to the upbuilding of the industrial affairs of this section of the province.

Although an eminently practical and exceedingly busy engineer, Mr. Fowler gives much attention to all branches of his profession and is a member of various organizations connected with this line of activity. He has membership with the American Institute of Mining Engineers, with the Institute of Mining and Metallurgy of London, is past president of the Canadian Mining Institute, and a member of the Franklin Institute of Philadelphia.

Mr. Fowler was married in 1902 to Miss Frances Hedley, a daughter of the late William Hedley of Halifax.

Fowler: Well, occasionally, but I don't remember anything about them. I have a photograph of Monsieur Riondel with Dad, but I can't remember the man at all. His grandson was out in B.C. about five years ago and my brother met him, but just after that he got into a fatal automobile accident in France.

Swent: So apart from the school, what other facilities were there? Was there a medical facility?

Fowler: No. No medical at all. I remember one case where a very good family friend, Mrs. Shaw, was about to have a baby, and she was going up to Kaslo to the hospital, which was about an hour's trip on the boat. At the last minute before she got on the boat, she was feeling pretty miserable so Mother got on the boat with her and administered the birth on the way.

Swent: On the boat. Oh, dear.

Fowler: So lots of interesting little things happened.

Swent: Was the school a part of your father's operation or was it a public government school?

Fowler: It was a government school, but to all intents and purposes, Dad was the school board. He certainly was open to anybody who wanted to come in and ask questions. I remembered that we decided one time, when I was in about grade six or so, that we should have room to play ball out in front of the school house. So Dad and a couple of other fathers and a bunch of us boys got out and cleared out a place to make a ball park. It wasn't a very big one but it was adequate.

It was a lot of fun. It was a very, very happy childhood, because on the shore of the lake, the last year I was in grade school-- Well, in the fall I had gone down right below the house to swim every morning until the snow fell. Then I started again in the spring before the snow was all gone.

Swent: The water was icy cold, wasn't it?

Fowler: Only once can I remember seeing a skim of ice on the lake. I had a little raft. I would take the raft--it was tied there with a good husky rope--and I would push it out and when it got to the end of the rope, I would dive in and swim to shore in as fast as I could. But it never hurt me.

Swent: Maybe that's why you're so healthy today.

Fowler: Could be.

Operations at the Bluebell Mine

Swent: Could well be. What about the mine operation?

Fowler: It was a substantial mine in 1910, small in today's terms, lead and zinc and some silver of course with the lead. It was operated for quite a few years but spasmodically because the price of lead fluctuated so much and so on, but Dad built a mill for the Canadian Metal Company and put in the power plant with about a three-mile pipeline with a seven-hundred-foot head that provided enough power to run the mine and the mill.

Swent: What kind of a mill was it?

Fowler: Gravity jigs and tables. Then in the 1920s, about 1925, they put in a flotation plant. They still used the jigs but the jigs produced a middling and the middling was further ground and then put through the flotation plant.

Swent: Were there ever stamps?

Fowler: No, because the stamps, as far as I know, were never used to any extent except for gold. But the mill at Ymir that Dad had run earlier had stamps, something like a hundred stamps or so. It started out just as a stamp mill where you recovered the gold on amalgam plates. Then a little later, they put in a cyanide plant.

Swent: With the lead and the zinc, how did they concentrate that?

Fowler: That's an interesting question because with gravity and that ore anyway, which had a lot of pyrrhotite and pyrite in it, you couldn't separate the zinc from the iron. That was essentially wasted. For a while, Dad set some out in a stockpile but that oxidized and so he couldn't recover it with any means that were available in his lifetime anyway. But there wasn't very much stock.

But you could get a good galena concentrate. That's what the mill produced for quite a few years from the time Dad first went there until the end of the war, when the price of metals was pretty low.

Swent: Which war?

Fowler: World War I. They couldn't operate economically for several years. Then in about 1923 or '24, Dad and a partner, Hank [Byron L.] Eastman, who came from the University of California and the

gold fields here, joined him first as an assistant, then as a partner, and they between them operated the thing for several years.

Swent: No longer for the French company?

Fowler: No. On a lease from the French company. On that lease they operated from I think 1925 until the fall of 1927, when there was a very sharp fall in the price of metals. That pretty well shut the thing down for quite a number of years.

Swent: Did you stay there, though, even when it was shut down?

Fowler: Yes. Dad was, well, I guess, he was about sixty-five by that time so they stayed on there. An interesting thing: the reason for that sudden drop in the price of, particularly, lead was that radios were becoming very popular and up to that time, they were all battery operated. Then somebody came out with the means of being able to plug them into the alternating current. Then the battery market dropped out and that shut the Bluebell Mine down.

Swent: Isn't that interesting.

Fowler: I think that's a reasonably factual statement. I was so young at the time that I don't remember much about it. Then, after that, Dad negotiated between the French company and Cominco (At that time, it was the Consolidated Mining and Smelting Company of Canada, Limited), and another party that owned two other claims on the same deposit. Cominco did some test work in the 1930s, in the early '30s, and then they bought the entire property. Dad and Eastman retained a small interest and the right to continue to live in the house, which belonged to the company. Dad and Mother stayed there until they died. Dad died in 1940 and Mother in 1950.

Swent: You were getting a wonderful practical education in mining.

Fowler: It was; it really was. I can remember, just for example, one time I was walking by the tailrace that came out of the mill. At lunch time I went home and said, "Dad, there's a lot of fine galena running down the tailrace."

"Yes, my boy. Now you tell me how to get it out and I'll pay you for it." [Laughter]

Swent: Your first metallurgical challenge.

Fowler: Yes.

Swent: What was the mining operation like?

Fowler: Essentially, open stopes because it was a lead-zinc replacement in limestone. The ore bodies were in sort of "chimneys" so that you would get an area of barren limestone and then a section of fairly good grade ore. But the size of the individual deposits was not so big that you could pretty well mine the whole ore body without support. One or two places they left pillars of ore, but they didn't have to leave much in the way of pillars.

The Bluebell Mine was a lead-zinc replacement in cavernous limestone. Therefore it occasionally experienced a flooding of the pumps. The old Cornish pumps handled flooding well, but had been operated in vertical shafts. The Bluebell in its early operation, from 1908 to the 20's, had a Cornish pump adapted to its 38 degree shaft. The plunger rod was made of spliced timbers--I think 8 by 8--operating between pairs of cast iron rollers. It was driven by a Pelton wheel on the adit level. About 1924 the Cornish pump was replaced by an electric one with its own independent Pelton-driven generator. Five Pelton wheels with line-shafts ran the crusher, mill, and machine shop, and provided water for the mill. A two-stage Ingersoll Rand compressor had a Pelton wheel about six-feet diameter between the two stages. Water came through a three-mile pipeline at a 700-foot head. Dad was responsible for design of the entire plant.

When Cominco operated later, about 1950-1970, it transmitted power from its hydro plants on the Kootenay River. The power line crosses Kootenay Lake in a single steel span of just over two miles, the longest anywhere when built. They operated at about 500 tons a day. So they produced a substantial amount of ore. An interesting thing about that: their mill (it was all flotation then), but they put their tailings in the lake. The lake bottom sloped down to about a 400-foot depth, and the tailing entered the lake from a pipe about thirty feet below the surface. Nobody ever saw any mud from it. It just all went down and there never was any problem.

Swent: Fortunate.

Fowler: If they were going to do it today, I don't know if they would be allowed to, but I am sure it never did any harm, and I don't think it affected the fishing appreciably.

Swent: Nobody even thought about those things in that day, did they?

Fowler: No. The Bluebell mill, the early one, they just ran a flume out into the lake without realizing what could have been done by putting it through a pipe discharging below the surface. That muddied up the water for maybe a hundred yards around.

Swent: I thought you were speaking of the Bluebell.

Fowler: Yes, I am. But when the Cominco operated it, they didn't operate the Bluebell claim. The Comfort claim north along strike, and the Kootenay Chief claim on the south, they did go down and explore those from the Bluebell workings to some extent. but the Bluebell claim gave its name to the entire operation. The Kootenay Chief claim had probably 80 percent of the total ore, and it was mined much deeper than the others. As depth increased, Cominco experienced hot water, much of it saturated with calcium bicarbonate. This caused precipitation as scale filling over half the diameter of the discharge pipe. It had to be removed by, I believe, adding hydrochloric acid at the pump intake. After descaling, they introduced water treatment to precipitate the lime before pumping. As the mine deepened, the water temperature increased as did the CO₂ content, both causing a ventilation problem. This shut the mine down before exhaustion of the lead-zinc mineralization. I am informed that someone is now using the warm water in a spa.

It is interesting to note that British Columbia abolished extralateral rights about 1892. These three claims predated that so the extralateral rights protected the claims a considerable distance out under Kootenay Lake, especially the deep workings on the Kootenay Chief.

Swent: So you spent all of your childhood in the same place.

Fowler: Yes, I did. Quite a contrast to our children. Our son was in thirteen schools in thirteen years.

Swent: That is a difference.

Fowler: I think I got the better deal on that.

Getting to High School by Bicycle and Boat

Swent: Did you have to go out for high school to some other place?

Fowler: Yes, I went to Kaslo for high school. That was about twelve miles away. At that time the CPR [Canadian Pacific Railway] steamers were still running, so I could get back and forth that way.

Swent: The steamers were part of the rail system?

Fowler: Yes. Tied in with the rail system. Sometimes, though, the thing is the boats ran the wrong way on the weekends, in a sense. I

could go home on Saturday morning, but then I couldn't get back very well because there wasn't any way to get back on Sunday night. I would have to go back on Saturday night.

Swent: So you stayed in Kaslo.

Fowler: Yes, I boarded with some folks there, a very nice couple. But quite a lot of the time I would bicycle down twelve miles along the lake and then I could get on the boat in the evening and go across and I could get back there on Monday morning. I don't think I was late for school doing that; I don't really remember.

Swent: That's quite a way to get to school. A twelve-mile bicycle ride.

Fowler: Well, it was only once a week, and I didn't go home every weekend. I spent some weekends in Kaslo.

Swent: You mentioned a brother. How many were in your family?

Fowler: I have a sister who is married and living near Montreal. My sister is four years older and my brother four years younger. He is a doctor living in Castlegar. That's on the Columbia, just north of the border, about thirty miles north of the Trail Smelter.

Swent: So you finished high school in Kaslo. What were you studying that had any influence on your later career?

Fowler: Not very much.

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Fowler: But because the high school was so small that there wasn't much opportunity. So they offered Latin and French and mathematics and chemistry. My sister, being older, told me that when I got to university, I would have to take physics to go into engineering. She said, "If you haven't had high school physics, then your professor will be Dr. Davidson and he isn't very good. If you have high school physics, then you'll have Dr. Shrum and he is wonderful."

So the last year, I talked to the principal and I said, "I would like to study physics." The school had a good little laboratory for chemistry and they had stuff for a lot of physical tests and so on. In the high school class, there were three boys and seven girls. We boys asked him if we could take physics.

He said, well, he didn't see why we shouldn't, but he wouldn't be able to devote very much time to it. We could study the physics in the laboratory and he would tend the class and



Bluebell gravity mill, machine shop, compressor house.
Designed by S. S. Fowler. Note ample windows rare at that
time. Circa 1908.

teach the girls Latin. I tried to carry the Latin as well, but after a couple of months, he came to me one day and he said, "Fowler, the way you're going at this Latin, I think you might as well drop it."

So I dropped the Latin. To get into university at that time, you had to have two sciences and one language, or two languages and one science. In spite of very little actual teaching in physics, all three of us passed the final exam, which was a provincial-set exam. That's about the only thing in high school studies that had any influence. It gave me enough to get into university and I was able to do well enough there.

The University of British Columbia, 1928-1933

Swent: Which university did you go to?

Fowler: University of British Columbia in Vancouver. It was a very good school, really. It was quite small. I think there were 2500 students. As I recall it, I don't remember when I started there, but the last year that I was there, 1933, there were pretty hard times and my recollection is that the annual budget for the university was half a million dollars.

Swent: How did the Depression affect that part of Canada?

Fowler: It was very, very apparent.

Swent: When did you finish high school and enter the university?

Fowler: I finished high school in 1928 and started university in the fall of 1928.

Swent: This is pre-Depression then.

Fowler: Yes. But the Depression was very much in full swing when I was in university. I remember that I was always fortunate to be able to find some sort of a job in the summers. Actually, the engineering school pretty much required that you spend your summer doing something related to engineering. But they were lenient on it. None of us had anything but laboring jobs, I think, but some of them did not relate much to engineering. I remember a couple of the fellows would go out on fishing boats for the summer. I know that some of them had difficulty, or found it impossible to get jobs. But personally, I never suffered at all. I got a laboring job each summer, except one summer I spent in the geological

survey, and other summers I had laboring jobs which were with Cominco.

I didn't know anybody that really suffered in the Depression as I know many people did in the United States, people in the Dust Bowl and so on. There must have been terrible hardships for a lot of people that I didn't experience and I didn't know anybody who did experience. But there was certainly no luxury. During the Depression, many people in the U.S. lost jobs. In 1929 and 30, Cominco at Trail had some labor shortages and men worked seven days a week around the clock. As the Depression brought on the need to cut payroll cost, Cominco employees went on a new rotating shift basis of fifteen days on one shift, five days off, and fifteen days on the next shift. That way, the work was distributed; layoffs and suffering were minimized. If many companies practiced that here now, would our homeless complaint be reduced?

The friends that I had at university, most of us were in a group known as the Outdoor Club. That was a wonderful bunch of people. To get into the Outdoor Club, you had to go on two work hikes at the little cabin they had and on one trip hike. Then after that, the existing members voted on whether or not they would let you in. It set up a required standard that--it really was a wonderful bunch of people. But I can't recall anybody in that group that had any appreciable money. One fellow had a car. I don't think any of the rest of us did. We would go up Grouse Mountain and sometimes he would take the car and take us part way up. I think you could drive up to about 1,000 feet elevation and then you had to hike another 2500 feet elevation to get to the cabin. The fact is everybody was in pretty much the same boat and you had never any luxuries, or practically none. I guess I did go to a couple of university dances a year, but that was about the only luxury. I think it really made for a very, very happy group of people, and life-long friendships.

Swent: Have you kept in touch with your classmates, with your friends?

Fowler: Oh, yes. Quite a few of them. An interesting thing in that respect was that one person--he was a year ahead of me--Neil Munro, in metallurgical engineering, and Jim Orr, in mining--after graduation we spread around and all of us have worked in foreign countries. Then we ended up here in the Bay Area where the three of us were all living within three miles of each other for several years.

Swent: That must have been a real pleasure.

Fowler: That's part of life.

Swent: Did you all work for Kaiser?

Fowler: No. I was the only one who worked for Kaiser. Neil worked for Dorr-Oliver; they had, and still have, an office right here in Oakland. Jim was in various things, was a bit into the uranium business and so on. Then when he came here, there wasn't much doing in mining and he taught geology at Merritt College for a while.

Swent: Maybe there are other things you would like to say about the university.

Fowler: Well, not too much, but I would certainly say we had a good basic education. It was good grounding in the theoretical parts of the various engineering disciplines, in physics and chemistry, and that background has stood me in pretty good stead. I've never really felt any lack of anything I needed in that respect. You certainly have got to keep on learning all the time. It seems to me that engineering, like many other things, is always changing.

Swent: There have been some tremendous changes in it, haven't there?

Fowler: Yes. But there was certainly an emphasis on integrity, and I would say when I graduated, we had the feeling that the essence of a profession was the willingness to put more into it than you expected to get out of it. Maybe you hoped to get more out of it, but for my part, I've practically never worked at a high salary, but I've had very interesting things in my jobs and I've had a great deal of happiness in it.

Summer Jobs

Helper at the Sullivan Concentrator

Swent: Did those laboring jobs in the summer give you experience that you valued or was it just something to pass the time?

Fowler: Well, they did. Let's see. After my first year, I went to Cominco's Sullivan concentrator at Kimberley. I started out there just laboring on some construction expansion project, but then when an opportunity came up I was moved into the mill, and most of the summer, I was the helper to the operator on the ball mills. The reason that the operator needed a helper was that if you should have a momentary power failure that shut everything down, then you had to start things up again as fast as you could before all the heavy material settled out. So the operator would restart the ball mills (there were four of them) and my job was to restart

Swent: It taught you patience, anyway, I guess.

Fowler: Yes. We had a rotating shift. On one shift, you had to hose the place down at the end of the shift. On another shift you had to shovel two hundred pounds of grinding balls into each ball mill. Well, that wasn't really very hard work. You didn't have to have a very big shovelful. But it was a little tricky because there was a three-foot long screen on the end of the mill and you had to get the balls shovelled in through the screen and into the entrance of the mill.

Swent: What kind of ball mills were they?

Fowler: Those were Hardinge mills. If I remember rightly, they were what were called 8' X 48". The Hardinge mills had a conical section on each end and a cylindrical section in the middle. The cylindrical section was forty-eight inches long. The diameter was eight feet. But it was interesting because I was able to get a copy of the flow sheet and to know what was going on and be able to talk to operators. I found it an intensely interesting summer.

Swent: It helped you when you went back to school?

Fowler: Well, not that. I think mainly it gave me a feel for the operating end of things so that when I graduated and was out on jobs, I knew what ball mills were and I knew what classifiers were and I understood a lot of things of the importance of them that otherwise I might not have.

Helper on the Geological Survey of Canada

Fowler: Then the next summer I was on the geological survey working in a coal field which, first of all, I thought I had no interest in coal but I found that it was intensely interesting in the very complex geology in the field that was being worked on a substantial scale. I was a helper and we had a chief and two senior geologists, both of whom had just graduated, and the two helpers. It was extremely educational because we were working out the details of the stratigraphy on a very complex field, and working with a good energetic senior assistant, it was a very interesting experience.

Swent: Was this also in B.C.?

Fowler: Yes. That was the Geological Survey of Canada.

Swent: It's a national survey, similar to our USGS?

Fowler: Yes. That was the Geological Survey of Canada.

Swent: It's a national survey, similar to our USGS?

Laborer in the Lead Refinery at Trail

Fowler: Yes. The next summer I worked as a laborer at the Trail Smelter where they were building a fertilizer plant. Then after working as a laborer outside for a little while on construction work, I worked in the lead refinery doing as I recall it tank testing. With a portable volt meter you checked the differential between each cathode and anode to find short circuits. A new soft lead cathode occasionally got bent so it touched the anode. You lifted it out with one hand and straightened it with a "spear" about three feet long in the other hand.

Swent: This was an electrolytic process?

Fowler: Electrolytic, yes. As the process continued nodules of lead would grow out from some of the more mature cathodes and the closer they got to the anode, the faster they would grow, and eventually short-circuit. So you had to keep knocking those things off using the same spear and they would just fall down to the bottom of the tank. Periodically the stuff was cleaned out of the bottom of the tank.

Swent: You had to do that manually though?

Fowler: Yes. It was all done manually. I don't know if it still is or not. The zinc plant is very much mechanized but I don't know if the lead plant is or not. Probably more so than it was then anyway.

Swent: It sounds like the sort of thing that you could mechanize.

Fowler: Yes, I would think so. They have been very successful in mechanizing the zinc. But I really don't know recently on the lead.

Cominco. Pioneer in Pollution Control and Fertilizer Production

Swent: What sort of fertilizer were they putting out?

Fowler: Of course, that grew somewhat from a geographical coincidence that the smelter was only nine miles from the U.S. border. When the wind would blow to the south, then there were farmers in the state of Washington who complained that it was destroying their crops. I don't doubt that it did do damage to them, but because of the international situation, Cominco was forced very early into corralling the smoke and getting the sulfur out of it. Then you couldn't very well dump the sulfuric acid in the river, so they had to do something with it. The answer was to build a fertilizer plant.

So Cominco has been a leader in fertilizers and pollution control since the twenties. There were times that that stood them in very good stead. For example, in the early part of World War II there was a great pressure on producing metals for munitions, but toward the end of the war, what was needed in many, many places was fertilizer. There was more profit in the fertilizer business than there was in the metal business for about a year or so toward the end of the war.

With the fertilizer, one of the interesting things was that you had to have phosphate rock. They did a lot of exploration in the Canadian Rockies but didn't find any commercial deposits, so the phosphate rock was all brought from the United States. Cominco had mines there in Montana.

The thing is that the phosphate is calcium phosphate. That lends itself to treatment with sulfuric acid which then gives you a waste product of calcium sulfate, which is gypsum, a pretty stable compound. You can dump that out and it doesn't hurt anything.

Swent: So they were inadvertently mining fertilizer.

Fowler: Yes. Maybe they would have anyway, but it was partly a matter of being forced into it. You get much more pressure from an international suit than you do from a national one.

Building a Road and Placer Mining

Swent: So those were your three summer jobs.

Fowler: Then there was one more summer still, because the next summer I was on construction of a road to a placer property that Cominco was investigating in Northern British Columbia. The road went north from a place called Fort St. James, which was a hundred-year-old Hudson Bay post. It was about one hundred miles to the

property. So I worked on building that road just as a laborer. For the last six weeks or so of the summer, I was laying out road. That was kind of interesting and fun. I laid out about twenty miles of road that is little travelled and probably still there.

Swent: What kind of equipment did they have?

Fowler: They had horse-drawn scrapers and axes. A lot of it was through timber and I sure cut a lot of trees down with an axe. I don't really think there is much of very historical significance. It was an interesting summer and I enjoyed it. An interesting little sidelight on it was that when we started we had a crew of twenty. There were eleven different nationalities.

Swent: That is interesting. Did you all speak English?

Fowler: Oh, yes. One or two where it was a little bit pidginny, but we could certainly communicate with no problem. This brings to mind that despite all the evils of any empire, the departure of the British Empire has left the world with what is fast approaching a universal language, a great step toward a peaceful world.

Swent: Speaking of nationalities, were you a Canadian or an American citizen?

Fowler: Well, I was born a dual citizen. Being born in Canada, I was a Canadian, but my father being an American, I was an American citizen. When we came over here, I entered the United States as a citizen. I have a certificate that says that I was an American citizen the day I was born.

Swent: So you never had to be naturalized.

Fowler: No. It so happens that I hadn't voted in Canada. As the law was then, if I had voted, I would have lost my American citizenship.

II A MINING ENGINEER FOR COMINCO, 1933-1946##

Swent: When did you first come to the States then?

Fowler: That was in the fall of 1948.

Swent: So when you first graduated from university, you went to work then for Cominco full-time?

Fowler: For Cominco, yes.

The Slate Creek, British Columbia, Placer Mine

Swent: Where did you begin?

Fowler: Actually, the first year after I graduated, I worked at the placer mine that we were building the road to the previous summer. I had carried on a bit of correspondence with Cominco to get the job lined up. Then I went home for ten days or so before I went out on the job. So I was to go up to the placer mine. The road by that time was completed to it. So I knew where half of the road was, but the northern half of it was new to me. It was just a wagon road. So I began to wonder when I was to go to this job, so I rowed across the lake and telephoned to Mr. Ritchie in Trail. He said, well, he would let me know. It would be fairly soon. A day or so later, I got a telegram that said, "You may proceed to Slate Creek immediately. You will probably meet Mr. Ogilvie somewhere on the road." [Laughter]

So that was the start of my professional career.

Swent: Do you remember what you were paid?

Fowler: Yes, very well. I was paid \$3.50 a day, and I paid a dollar a day for board.

Swent: Did they have a boarding house provided for you?

Fowler: Yes. We lived in a tent until Christmas time. Then several of the crew left and so then I was able to move into a little one-room cabin with three other men.

Swent: Did they provide furniture and bed linens and that sort of thing for you?

Fowler: It seems to me that there were a few boards to make a frame. I cut some branches and made a bough bed and I used a sleeping bag on it. The tent had a stove in it.

Swent: What kind of fuel?

Fowler: Jack pine.

Swent: You burned wood in the stove?

Fowler: Oh, yes. There was nothing else there. There were four of us in the tent so every fourth morning, you had to take a turn at getting up when it was as much as 50 below zero and starting the fire.

We were erecting machinery for the placer operation. It was a drag-line affair and we built a number of cabins, a building for an office and several residences and a cook-house.

Swent: When you say placer, was this in a river?

Fowler: Well, a small stream. It had been operated as a placer about 1860 or so. Then it became idle and wasn't profitable enough, but it was a deposit that they did some drilling on.

Swent: This was gold?

Fowler: Yes, gold. Then they decided there was enough to establish the drag-line operation. It was a steam-engine donkey that you fired with cordwood. So we did actually get it operating. We operated for a few weeks in the fall and then we did some more building and cutting a supply of cord wood for the summer. We did some underground test work on the placer, so most of the time I worked on that with a couple of other men with just a hand-operated windlass. We sunk down to the bedrock and then drove a bit of a drift on the thing.

Surveyor at the Sullivan Mine at Kimberley

Fowler: Then I got moved down to Kimberley. Then I was promoted to staff work. At Kimberley, that's the Sullivan Mine, I started there at \$125.00 a month. When I got my first paycheck there was a little note with it that said that all the staff has voluntarily accepted a ten percent pay cut. [Laughter]

Swent: But this was the first you had heard of it.

Fowler: That was the first I had heard of it. But I lived in a staff house there, which was comfortable. I think we had two beds in a room. The boarding house was not far away; they served good meals at \$1.00 per day. But I was working as a surveyor which, in a sense, is a pretty lowly job. On reflection, that was a wonderful opportunity for learning. After a few years there, during which some of the time I was away from there to other places, I had a comprehensive knowledge of the entire mine layout, and it was a pretty good operation then, about 6,000 tons a day.

Swent: You were surveying underground in the mine.

Fowler: Yes. There wasn't any place in the mine that I didn't know exactly how to get to and so on. I was in workings all over the place. I had a good understanding of the mining method and of the transitions that were going along at the time. It was a very interesting time to be there. When I went there, it was all open stopes. It was a massive sulfide ore body, a tremendously big lens. The largest open stope in the mine--I actually surveyed in it--was four hundred feet long and one hundred feet wide and two hundred eighty feet high.

Swent: It must have been very stable rock.

Fowler: Yes, extremely stable rock. Very, very few accidents. From the time I first went there, with a thousand men a day underground, they operated for four years without a fatality. I think that's pretty good.

Starting Sub-Level Mining

Swent: Yes, it is.

Fowler: One of the first things I learned was that if you were going to work there as an engineer, you were going to set an example of

safety first. That was the first essential. It was the time they were just getting ready to start sub-level mining because it would be a lot safer. And probably in the long run more efficient. So we were working in a lot of these places where you would go in and do the development for the sub-level mining. We were able to see that and understand the advantages of it. Then because they had these enormous stopes, in order to mine the pillars (which were mined by the same sub-level technique) you had to fill up the old workings.

So we drove raises up through the pillars and then out over the backs of the stopes and on up to the surface. These raises were about seven hundred feet as I recall it.

Swent: Were they vertical or inclined?

Fowler: No. They were inclined raises. But most of it was pretty steep. They were about seventy degree raises as I recall it. Incidentally, just as a way of looking at these things, most places, when you go out and look at a slope and you think, "Gee, whiz," you look down a hillside, "that's got to be at least sixty degrees." But if you measure it, it's probably less than forty. These raises were actually seventy degrees. Of course, they were timbered all the way up in order to be able to get up them, or they were then. Nowadays, a lot of this sort of thing is done with these so-called Alimaks. They are a thing that was developed in I think Sweden, possibly Norway, but that means that you can run the raise without having to have it timbered.

Swent: Those were all timbered, though.

Fowler: Yes. You timbered it to divide the raise into two parts, one of which carried the muck and the other the ladderway. Those raises went right up to the surface and the last one or two hundred feet probably was in glacial till, which was what they wanted to use to fill the stopes with. I was there when the first of those raises broke through. I remember the start of the filling. The stopes underground, a lot of them, were fairly flat on the bottom. To get the last of the ore out, they had to use slushers. Then they tried using a slusher to rake this glacial till into the raise to fill it. After they would get the raise up there, then they would blast and break it through into the back of the stope below.

So they did that for a while. But the slushers just weren't heavy enough. Then they got bulldozers. As I recall it, the largest dozer available at the time was a D-8. They used those and that got a lot of fill into the mine. As time went on that was too slow so they started using trucks. They used Euclid trucks which were the biggest that were available at the time. This would be in the early 1940s. I think they were thirteen-

cubic-yard trucks and six-yard shovels. That seemed pretty big equipment at that time.

Swent: Who made the slushers? Do you remember?

Fowler: No, I don't. It's possible they built them on the job, but Ingersoll-Rand used to make some of that equipment. I'm not sure. The slusher hoists I think were Ingersoll-Rands. But two or three of those machinery outfits made that equipment.

Swent: When they drove these raises, what sort of machines were they using?

Fowler: Those were the same as they would use in drifting. They were mounted on a bar. You put a bar with a jack screw in it and you would put the bar in place and then use a lever and you would jack the thing up tight. Then you would drill from that. But in the raises, I think they used stopers. The stopers have an air cylinder in them that feeds the thing up. In later years, I'm sure they used the jacklegs.

Swent: This is before jacklegs?

Fowler: That was before the jacklegs.

Swent: What kind of explosive were they using?

Fowler: I would say it was Forcite gelatin. I think that's what it was called. Probably 50 or 60 percent strength. It's essentially dynamite. It was called Forcite gelatin, for most of it anyway.

Communicating an Effective Safety Policy

Swent: You mentioned their emphasis on safety. How was this communicated to you?

Fowler: I can tell you a little story on that. There was no question about the general philosophy. But for instance, to take the men underground, there was about a mile-long adit. They had a train that you could sit probably ten men on each car. They would sit back-to-back on a little bench with a back to sit against. They would take the men in on that in the morning and bring them out in the evening. But during the day the surveyors very often would be underground for three or four hours and then they would come out. So they would ride out on the locomotive of the ore train. You just sit on the locomotive.

One day, I was waiting--. When you went into the mine, you came first to the south end station. Then it would go on up to the north end station, but there was a side track there for the trains to load up on the south end of the ore body. The north end train was ready, waiting to go out. It was delayed because I think the general manager got on a telephone call and he was delayed going in, so the dispatcher was there waiting for the train to come in. Then as soon as the train got clear of the switch at the south end, he signalled to the train that was maybe a couple of hundred feet up the track. You would signal with a light just by waving it in a big circle and being behind hand, well, that meant sort of give it hell, which meant that you would travel--I think they rode about twelve miles and hour, maybe.

So it came past the south end station at about maybe six miles an hour. Then as it got there the dispatcher said, "Oh, gee, Pete, I forgot." He was in a hurry to get the train moving. He says, "Can you make it?"

I said, "Sure," and I hopped on. I really didn't feel there was any risk at all. It wasn't going that fast and I just got on the train and sat there.

At lunch time, the general manager came and said, "Pete, I saw you get on that train. Don't let it happen again."
[Laughter]

In other words, what he was saying was, you know the rule and if you've got to sit around or spend half an hour of company time walking out, that's one thing; but you don't get on a moving train. That was the way it was communicated; I've never forgotten. It certainly was the philosophy in everything. If you're going to work in this mine, you're going to practice safety first. As an engineer, you're going to set the example. So that was the way it was, anyway. It's a lesson that I've remembered for fifty years.

But the essence of it is, as far as I'm concerned, that if you want a safe operation, the top management has to make safety first the rule. They did. I always get worked up when I talk about that.

Swent: It's very important.

Fowler: It does pay. I think there is no question about it. But when they said safety first there, they meant it. There wasn't any question about it. I think there are places in the world today, in this country and probably in others, that the top management means safety first when it doesn't cost us much.

Swent: Did you think of this at all when you went to work for them? Were you aware of this before you went to work for them?

Fowler: I would say, yes but not with as much emphasis and insistence. They certainly did, in general, instill a safety attitude.

Swent: I guess I was just wondering whether you thought in terms of selecting a company to work for that was safer than another one. Mining is considered a risky occupation. At that time I guess you didn't have much choice, did you?

Fowler: I picked the only place I knew I could get a job. I admit that I didn't look at very much else. I was offered a job there and I just took it. There is no question about the risk in the mining business. But you have just got to keep minimizing the safety risk all the time. You establish rules that tend to reduce accidents and you stick by the rules. I must interject, however, that there are limits. It is impossible to eliminate risk completely and it is part of an engineer's job to assess risk and inform those concerned of that risk.

I remember, too, when I went to work later with Kaiser that they had a very high premium on safety. I remember one operation with them. We were starting up a mine and we went and talked to the Bureau of Mines. They had an office in Berkeley then and we got the representative from there to come up to the mine with us and talk over safety and see what recommendations he could make to improve the safety of the operation. Kaiser was very, very good on safety. They really emphasized it.

Swent: Built it in right from the first.

Fowler: You bet. I thought the Sullivan Mine was interesting. I was able to see the transition to the sub-level mining and the start of the filling of the stopes and the start of the mining of the pillars. I wasn't working there then but I was still with Cominco when they started it and I was back there to the mine on one or two occasions and was underground when they started that. Each pillar was sort of mined like a sub-level stope, but then of course you had waste packed all around it.

Swent: Those must have been huge pillars.

Fowler: Oh, they were. I've forgotten for sure but I think they were probably fifty feet thick and then extended all the way from footwall to hanging wall, two hundred to three hundred feet in the center of the deposit. The ore body was roughly speaking, say, a mile square. So it did lend itself to a very systematic layout. After you got your development in the pillar, and mined out what you could from there, then you still had a shell with a large

quantity of ore and you reached a point where, when you made a certain blast, then you could never go back in again, because the whole thing was shattered. The only access was in pulling the stopes. The ore body has much pyrrhotite and pyrrhotite is susceptible to spontaneous combustion; in other words, it oxidizes very readily, so some of those stopes actually took fire. I think they had more than one fire. They had quite a time when that was the case, but after that they made a point of once you made the final blast, you concentrated as much as you could on getting most of the ore out of that one stope.

For example, when I worked there, we used to sample all the stopes at regular intervals, so we knew the grades of the various stopes. You would pull stopes to give you a uniform grade going to the mill, as nearly as you could. But when you had this, once you blasted that pillar shell, you just concentrated all you could on pulling that one stope, so you might unbalance the grade a little bit for a while, but anyway that was what was done there.

The History of the Sullivan Mine##

Fowler: A couple of other things about the Sullivan. A little bit of history that wasn't my own experience. The mine was discovered in 1892. It was operated spasmodically on a small scale. They produced some high-grade lead ore through World War I and so on. Cominco took an option on the property in 1909. They exercised the option in 1910. Then they started a program of experimentation. As I say, they mined some high-grade selectively and did hand-sorting. But they tried all sorts of things to treat this ore; it was extremely difficult to treat.

When flotation was first developed, I think there were some places where they did a little bit selectively. In other words, you got maybe, say, a copper-zinc ore. The first flotation was applied to separate the copper and zinc from the waste material; then you had to do what you could to separate those two minerals. If the ore was coarsely crystalline, I think they did make some flotation separations. But the Sullivan ore was very fine-grained and had a very high proportion of iron, in other words about 15 percent lead plus zinc. Then the rest of it was iron, all of those as sulfides, so that maybe you had roughly equal parts of, say, iron and sulfur and 15 percent lead plus zinc.

But that was extremely difficult to treat. There wasn't any means known of doing it. Ralph Diamond was brought in there. He had done some flotation work for Anaconda. He was engaged to try to work out processing for the Sullivan ore. He started work with

them in June of 1917. They did very elaborate flotation testing, but combined it with magnetic separation--you have to roast it in order to get magnetic separation. By and large, it took them until 1920 to be able to build a plant at all. Then they built a concentrator at Trail. That concentrator, as they went along and developed it, became the basis for design of the Sullivan concentrator. They finally built the Sullivan concentrator and started operation in the summer of 1923.

So there were six years of concentrated work on trying to develop a process and to design a concentrator; that's starting in 1917. but they had exercised their option in 1910. I have often thought of that in relation to modern ways of looking at investments. If somebody had required a discounted cash flow analysis from the start, I can't see how they could have done anything but turn that mine down. But that mine has over the years--from the start of the concentrator at Kimberley in 1923, until the end of 1989, produced lead in concentrate 8,398,000 short tons, and 7,252,000 short tons of zinc. At that time the reserve had about a million tons of lead still and one and a half million tons of zinc so that the total ore body on that basis, and this is probably a slight understatement, is well over 9 million tons of lead, almost 9 million tons of zinc, or a total of well over 18 million tons of valuable metal in one ore body. [Laughter] It's fantastic. Incidentally, the silver-to-lead ratio was well established all over the mine when I worked there at three ounces per unit (1 percent) of lead. Projecting that to the total ore body gives 2,700 million ounces of silver. All that omits significant production prior to 1923.

Swent: It's overwhelming, isn't it.

Fowler: Yes.

Swent: But it took them many years to bring it to production.

Fowler: Well, let's see. It was discovered in 1892 and it was 1923 before it became really a good operation.

Swent: Over thirty years, then.

Fowler: Yes. But of course, much of that time, they were just piddling at it. It's a pretty fantastic thing.

Swent: Yes. Now, I'm a little confused here. You're speaking of Trail and Sullivan and--.

Fowler: See, the Sullivan Mine is at Kimberley in British Columbia. That's near the southeastern corner. It's about two hundred miles by rail from there to Trail, where the smelter is.

Swent: So it was concentrated at Sullivan and smelted at Trail?

Fowler: And smelted at Trail. Just quickly, the background of that. There were copper-gold mines discovered at Rossland in British Columbia in, I think, 1890. Trail is about seven miles from Rossland. The Trail smelter originally was built by Augustus Heinze from Butte on a contract to treat 75,000 tons of copper ore from the Rossland Mines.

Swent: It slightly over-exceeded its contract. [Laughter]

Fowler: Yes. Then the smelter from that little beginning expanded. It was close to a source of hydro power on the Kootenay River, just before the Kootenay joins the Columbia. So it just sort of naturally grew. There was once a small smelter built near Kimberley, but there was too much zinc in the lead ore to operate it successfully.

Slag Fuming the Lead and Zinc at the Trail Smelter

Swent: I have the words slag fuming here.

Fowler: Slag fuming was a development at Trail.

Swent: Were you involved in that?

Fowler: I wasn't involved in it but I can tell you a little something about it because I worked a summer at Trail in the early stage. To treat the Sullivan ore, they did experimental work quite early on an electrolytic zinc plant. But it wasn't really successful until they got the Sullivan concentrator going. But they did treat quite a bit there from the preliminary concentrator which operated up to about a thousand tons a day, I think, at Trail as the basis for design of the Sullivan concentrator.

But initially, there was a high zinc content in the lead smelter feed, but until they got successful concentration they couldn't separate it. The presence of that zinc affected the capacity to separate lead in the lead blast furnace. So the lead slag was rich in lead and also had a lot of zinc in it. Then to reduce that loss, and also treat a lot of accumulated residue from previous slag and from the zinc plant, they built this slag fuming plant in which you take the slag from the lead blast furnace and you put it into this slag fuming furnace while it is still molten. Then you blow powdered coal into it. That raises the temperature up to where you actually--. The powdered coal reduces the lead

oxide and the zinc oxide to metal, and then the metal evaporates so that you get a fume of lead and zinc. But when they get up into the flue they immediately oxidize in the air that's present. So you collect the lead and zinc as an oxide fume. Then they had a special leaching plant at Trail to recover that metal. So that was the essence of the slag fuming, a Cominco development. It was a significant part of the success of Cominco's operations. It was pretty important and I think it's worth mentioning as part of the overall picture.

Swent: Did you work at Trail at all?

Fowler: Yes, earlier, but that was just as a laborer, and I found it very educational. But I worked there for several years later.

Swent: I see. But this present job at Sullivan was only at the mine there at Kimberley.

Fowler: Yes. So what I've told you I think pretty much sums up the job at the Sullivan and its relationships and appreciation of the history of the thing and the overall setup.

"The Cominco Story," a series of eleven articles, has been published in ORBIT, the Cominco quarterly (March, 1988 to Fall, 1991). These give a very readable history of progress to date. I have a set of those and two other publications that I'd be glad to turn over to The Bancroft Library for back-up information. the others are "A Detailed Account of the Development of the Treatment by Flotation of the Ore of the Sullivan Mine, Kimberley, B.C." 1917-1923, by R.W. Diamond, and "Cominco: modern, resourceful, successful." (An outline at Cominco's many operations worldwide.) [Engineering & Mining Journal] 1973.

Swent: We're getting up to World War II now. What effect did that have in Canada on the mining business? Canada never closed its precious metal mines the way we did here.

Fowler: There are a couple of things that come in before that, and it would keep it sort of in sequence.

Swent: Do that then, please.

Assistant to MacLeod White at McDame Lake, British Columbia

Fowler: The summer of 1937, I worked in Northern British Columbia on Table Mountain overlooking McDame Lake, pretty close to the Yukon boundary of British Columbia. One of the significant things about

that job was that I was working for a fellow by the name of MacLeod White. I have to say, more than fifty years later, he was the finest man I ever worked for. A man of absolutely unquestionable fairness and integrity. I just still remember it as being so outstanding.

The interesting thing about it was that it was an extremely interesting gold outcrop. We traced it for 6800 feet. Its average width was 4.7 feet and the grade was .53 ounces gold per ton. And we turned it down. [Chuckles]

Swent: Why?

Fowler: Well, we took a couple of diamond drills up there and we drilled it and we found out some very interesting things with that. The average width in the drill holes, instead of being 4.7 feet, was only 2.3, and the average grade was--I have it in some notes here, I'm pretty sure--.23 ounces. I think that the lower grade was quite likely a factor of that the gold tended to be in graphite seams. When we drilled it, we got rather poor core recovery. That probably largely accounts for the lower grade.

It was extremely remote. The remoteness has been overcome since, but besides those things, even if the grade had been the same, it was much narrower and where, on the surface, it was steep, about 65 degrees which is a nice slope to mine underground in shrinkage stope for example, but it flattened down to about 30 degrees. It had a very weak hanging wall. So with all that combination of things, still nobody has ever gone back to mine it.

Incidentally, I wrote a report on that. MacLeod White wrote the main report but I wrote one, which was the basis for my registration. To get registered as a professional engineer in British Columbia then, you had to get four years of postgraduate experience, and then write a report on some engineering undertaking. One other little thing about that was that when I went up there, I was told that I was expected to do enough surveying that the management could sit in the Trail office and decide where to drive a tunnel into the vein.

When I got up there, I took a look around at the situation, and I decided that there was no possible way I could do enough surveying in the summer to accomplish that. I had an old post-card-sized camera. I set up some places that I could survey and I took a series of photographs from those. Then I triangulated distant mountain peaks and so on in every photograph. Then I was able to use those photographs. I could locate each photograph by the point triangulated in it and then use the photograph to do further "triangulation." I made a topographic map of an area of probably fifty square miles or so.

Swent: This satisfied the requirement?

Exploring for Bauxite in British Guiana

Fowler: Yes. After that, I spent a year in British Guiana, or now Guyana. When I first went down there, I was working with a fellow by the name of Ade [Adrian] Hudson who was down there on a gold prospect for Cominco. So the manager of mines decided, "Well, if we're going to be down in British Guiana, why don't we look at bauxite?"

Ade said, "Well, I've got to have a helper." So I was sent down as his helper. After a little bit of orientation out on the gold prospect with him, then I went looking for bauxite. Incidentally, to get to British Guiana meant a four-day rail trip from Vancouver to Halifax and two weeks on a cargo ship, and a similar return trip via New York.

Actually, after a year, Cominco decided they weren't very interested in getting into the aluminum business, probably didn't want to go into raising that much capital. We did find some interesting things there, but I thought it was very interesting that I had the opportunity to go and look at what is perhaps the most unusual bauxite deposit in the world. This was on what is known as Yarakita Hill. There was some information on it from the local geological survey. The description was that it was a large hill covered with bauxite boulders. Presumably, if there were that many boulders, well, there is a pretty big deposit. Well, the location was sufficiently described that we were able to go to it. I think we were able to go by boat to within a half mile of it. There was a pretty small stream in there, but anyway, I went out and sure enough, there were bauxite boulders all over the place. Beautiful-looking bauxite. We went on and looked at it. As we went up the hill, it suddenly, very abruptly, stopped at a given point going up the hill. The upper limit was gradually climbing up the hill as you went one way. We did some trenching at the upper limit. In every trench, we found the same thing. There was a zone of bauxite going horizontally into the hill about a foot thick. A foot of bauxite is useless. A matter of fact, it isn't bauxite because bauxite is a commercial term. If it isn't economic, it isn't bauxite. It still is essentially gibbsite, which is the mineral that is most desirable in bauxite. That's essentially aluminum hydroxide. I came to the conclusion that there had been a dike nepheline syenite that cut through the hill and the leaching of surface waters going down had changed this dike into practically pure gibbsite. But that's all there was. It was only a foot thick. Yet it was quite easy to see how

somebody just casually looking without any investigation would take the thing to be a very large deposit. It was quite remote so I doubt that anybody has ever mined any of it since.

In one of the trenches, I found three beautiful pseudomorphs. A pseudomorph is a geological form in which an original crystal is altered chemically so that is a new substance but it takes the form of the original crystal. One beautiful hexagonal crystal about six inches in diameter and about two inches thick. These crystals--I still have one of them and one of them is, or was, in the mineral museum at Cominco's Trail office, and one was in the Geological Survey's mineral museum in Georgetown, Guyana.

It was a fascinating experience being down there, apart from the fact that I got malaria. You know, you could go on and say a lot of things about it, but I was glad to have the chance to analyze a very unusual deposit. I examined one potentially significant deposit at the edge of deep water on the Essequibo River, but Cominco lost interest because, I guess, they just weren't prepared to make the investments that would have been necessary to enter the aluminum business.

We did know about the situation which ALCOA, or ALCAN, subsequently developed at Kitimat, where they have a very substantial aluminum reduction plant based on damming lakes at the head of the west tributary of the Fraser River with lakes at elevation of 3,000 feet and dropping water down to sea level by tunneling through the Coast Range. We knew of that availability there and thought about it at the time, but anyway, Cominco didn't do it. So that's the only time Cominco ever did any bauxite exploration. Then from there, I went back to Trail, B.C., then the operating head office.

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Swent: So you went from the cold to the tropics and then back to the cold.

Fowler: Yes. On leaving the north I had bought a minimum recording thermometer and the lowest reading the next year was +71.5 degrees Fahrenheit.

Swent: But you had malaria.

Fowler: Yes. I got malaria shortly after I went down there and was in the hospital for a week or so.

Swent: Where?

Fowler: In Georgetown.

Swent: Did the company take good care of you?

Fowler: Oh, yes. No question about that. That brings up an interesting little thing in terms of medical care. I don't know if there's much more to talk about in British Guiana.

Then I went to Trail, B.C., then the operations head office. At Trail and at Kimberley, and I think all other operations, all employees paid \$2.00 or \$2.50 per month into a medical fund, which employed several local doctors and had small hospitals. That monthly fee provided for total medical care, including prenatal, birth, and child care. The fee did not increase while I remained with Cominco, through February of 1946. As an employee, I thought that was a pretty good service, and it covered the birth of our children. The doctors did not appear to be suffering and were certainly respected members of the communities.

Just after I went to Trail, I got married.

A Shipboard Romance That Lasted

Swent: Where did you find Kay? You haven't mentioned her yet.

Fowler: No. Maybe I should have. I was sent by Cominco on a trip to examine a prospect at Cordova, Alaska. Kay was a violinist in the ship's orchestra. So we started correspondence from that.

Swent: You went up on a ship?

Fowler: I went up on a ship, yes. I had a bunch of photographs with me and I was showing her some of these photographs on the trip across the Gulf of Alaska. She thought they were pretty nice. Then I said, "Well, if I get some good photographs on this trip, if you give me your address, I'll send you some." So that was fatal as far as she was concerned. We started correspondence and actually, well, this is an important part in British Guiana. Then we corresponded through the summer I was up at McDame Lake. Then when I went down to British Guiana, I wrote and told her that I was going to be down there and she said, well, she had been making plans for the summer. She was going to go for a cruise from New York through the Panama Canal. She was teaching at Stephens College in Columbia, Missouri. Then at the last minute, or maybe not quite the last minute, there was a likelihood of a strike on the ship and so she changed and went on a Dutch boat. The Dutch boats went from New York down to the Caribbean; they stopped in

Georgetown and Paramaribo in Dutch Guiana, and then they went across the Atlantic. Then another ship would come back the other way. After three or four days in Georgetown, she could get on the other boat and go back. So we had a few days down in British Guiana together. That's where we made our most important decision. We got married in Seattle in 1939. It has been an extremely fortunate marriage from my point of view.

Swent: She had no background in mining, then, at all.

Fowler: No, none at all. But she had travelled the Alaska steam ships for quite a number of trips and got to know some of the Alaska people and so on.

Anyway, then at Trail. I had just been working at Trail a month or so when we got married. Then there was an interesting little personal thing there. Just before I got married, I was out with a couple of other fellows to dinner at somebody's home. Charlie Wright had a Ph.D. in chemistry and he was a big shot in the research at Trail. We were down there and I guess it became known that I was going to get married and so they asked about who I was going to marry and I said, "She is a teacher at Stephens College, Columbia, Missouri."

"What does she teach?"

"She's teaching violin."

Charlie said, "Well, I see where you and I are going to be spending some long winter evenings together." His wife was an excellent accompanist.

When we got back to Trail after our brief honeymoon, then Kay and I were down at the Wright's for dinner one evening. Mary and Kay got busy with the music and Charlie and I played cribbage. Mary was pretty well known in music circles around Trail. They had a small orchestra there. So anyway, what Mary Wright said kind of carried weight.

Mary got in touch with the conductor of the orchestra, Hans Fodomschmidt, a Dane who was working in the smelter as a pipe fitter. The orchestra was all volunteer, of course, but in the fall, when they were ready to start practicing, Kay was invited to go down to the practice and I took her down to the first practice in Trail. We were living in Rossland. We walked in and Hans came up and said, "Well, I've reserved the concertmaster chair for you." While we were in Trail, she was the concertmaster for the Trail orchestra.

Swent: How nice that she could do that. It must have added a lot.

Fowler: I think she thoroughly enjoyed it.

Swent: And the community must have too.

Fowler: Yes, they did. She played a fair amount there. She played quite a few solos when they had concerts and so on.

Swent: Did she continue to teach at all?

Fowler: I think she had one pupil in Rossland. I think she enjoyed it and the girl did. Anyway, all things come to an end.

Assistant to the Manager at Trail

Fowler: Some things at Trail. You mentioned the gold mining aspect. Congress had decreed that there should be no munitions or anything of the sort given anywhere on credit. Canada needed a lot of things from the United States and everything had to be paid for. The only way we could pay for it was gold. So, where the gold mines were shut down in the United States, in Canada they went full blast all through the war.

Another interesting thing, somewhat similar in relationship. Shortly after I went to Trail, the executives of the major mining companies in Canada concluded that war with Hitler was inevitable. They negotiated with the Canadian government and made an agreement that they would sell lead, zinc, copper, and nickel to the Canadian government at current prices adjusted for inflation if necessary. They did have effective price and wage control in Canada throughout the war. As a result of that agreement, throughout the war Cominco sold lead and zinc to the Canadian government at a price lower than the average for any five-year period in history. That was a very significant thing. The company did well on it because they had no selling cost.

Swent: They didn't have to market it at all.

Fowler: It makes an awful big difference. Then some other things at the time. Cominco had a large volume of reports of mining properties all over the world, but particularly all over Canada. Mr. Diamond was the man who was running things sort of as general manager. He didn't actually have that title then, but he was the general manager. He had taken over as manager of mines. The president, Mr. Blaylock, lived at Trail. I think the former manager of mines had a falling out with him or something. Anyway, Diamond took

over in that capacity. He was the man who had developed the flotation for the Sullivan ore.

He decided that he wanted reviews of a whole lot of things that had happened in the mining department as to why some things had been successful and why some others hadn't. So there was a large volume of report work to review these things. I had the good fortune to work on some of that under Frank Fortier, who was excellent at writing. I certainly had an opportunity to learn that writing is one of the most important of engineering functions and to polish my skills at it working with Frank Fortier.

Continuing on later, I worked directly under Mr. Diamond for a couple of years, which was a fascinating experience. He was a very demanding person, but somebody to whom you could always go with an idea and it would always be considered. Maybe he didn't agree with you but if he didn't there was no question that he was taking responsibility for disagreeing and that was it. But a very, very inspiring person to work for.

One of the things that we did there was to review all these reports and summarize them. A total of over 4,000 reports. Gerry Beaujolais was my assistant. He came up with an idea that I was responsible for carrying out, and that was to further summarize and transfer all these summaries onto the IBM tabulating machines, which were the forerunners of computers, and were then used mainly for payroll and accounting.

Tabulating Mine Reports

Swent: Were these punch-card tabulators?

Fowler: Yes, punch cards. So we had a punch card for every individual property. On those, we were able to outline what were the metals and the geographical location and the quality and then various other features of the property.

We had this set of cards. For instance, one use that they were put to, one time in the 1940s there was a marked increase in the price of silver. We were able to run a list of all the silver properties in order of merit and just come out with a tabulated list of them and then review them to see what was significant. As I understand it, after the war, that set of records was made available to the provincial government and became the start of a province-wide inventory that was later expanded to, I understand, a dominion-wide inventory. It's sort of the forerunner of what is

now a much more elaborate system of the U.S. Bureau of Mines. I don't know if the Bureau of Mines picked it up at all from Canada or whether theirs was a completely independent development. But I think at Trail we were several years ahead of them on it anyway. It was very interesting to work on something like that.

Again, when the idea came up and you went to Mr. Diamond with something like that, he said, "Gee! That's great! Go ahead." It's pretty inspiring to work with somebody like that.

Swent: Yes, indeed. That might be a good place to stop.

[Interview 2: April 2, 1991]###

Swent: I had asked you what Cominco stands for.

Fowler: When I worked for them it was The Consolidated Mining and Smelting Company of Canada, Limited. They had the cable address of Cominco. One time they decided to publish a magazine. They had a competition and somebody came up with the idea that they should use the cable address as the name of the magazine, the employee magazine. Ten years or so later, they changed the corporate name.

Swent: Well, that's right in line with ASARCO and some others that have done that. It's easier. It's always called Cominco, isn't it?

Fowler: Well, technically it's Cominco, Limited, now. That is the corporate name.

Swent: When we finished the other day, you had just finished working with your IBM punch cards and doing an inventory. Then you went off to Texada Island. That was still with Cominco?

Fowler: No. That was with the Pacific Lime Company.

Swent: How did you happen to leave Cominco?

Fowler: I left Cominco essentially because I had a disagreement with the fairly newly appointed manager of mines, Bill Jewitt. I remember a friend in Vancouver with Cominco, talking to him one day about a possible change, and I said, "I don't think Jewitt likes me very much."

He said, "Don't you know that, Pete?"

I said, "No, I can't say that I know it."

He said, "Well, I know it." [Laughter]

III GENERAL SUPERINTENDENT FOR PACIFIC LIME COMPANY, 1946-1948

Texada Island

Fowler: Anyway, this same fellow had a friend who was the general manager of Pacific Lime Company. They were needing an engineer as a superintendent at the quarry and plant. They had a lime burning plant on Texada Island. They had had a sawmill there but the sawmill burnt down about a year before and they never reestablished it. It worked nicely because they could burn some of the sawdust and slabs in the kilns. Then just before I went there, they switched over to burning coal in a gas producer, making gas to burn in the kiln--this producer gas--which has a low heat value but it is already hot as it comes out of the gas producer and then you burn it in the kiln where you have better control over the combustion than in the former wood-fired kilns.

They also had a small rotary kiln, a very small one. The quarry was right there, less than one hundred yards from the plant.

Swent: So the plant was crushing and also burning?

Fowler: Well, when I went there, the limestone was broken in the quarry by hand by Chinese laborers. The rock broke easily and this gave a high proportion at the ideal size for the vertical kilns--six to eight inches.

Laborers and Wages

Swent: Were they brought over from China?

Fowler: No, they had probably come to work on the railroad or something of that sort. So there were probably thirty or forty Chinese laborers there.

Swent: What year was this?

Fowler: That was 1946.

Swent: Do you have any idea what they were paid?

Fowler: Yes, they were paid sixty-five cents an hour Canadian funds. That was the basic wage at the plant. There were a few other laborers there too who were at sixty-five. I don't remember the top of the scale for mechanics and so on, but it was, I would say, low in British Columbia standards, but not all that low. Shortly after I went there, we had union negotiations. As I recall it, we added ten cents an hour to the base. The general manager was very much opposed to going up that much in the wage. He didn't think we could afford it. I remember his arguing, "You pay an extra ten cents an hour but people aren't going to do any more work."

I said, no, but we had a fairly high turnover and I thought that the increased wage would enable us to hire better recruits. I still think it probably did. We had a few young fellows there who had returned from the war.

The plant was very crude in many respects. It had been built many years before. They built a new kiln with a new gas producer while I was there. One of the problems with the original gas producer was that it was built to be fired with coal. The available coal from Vancouver Island clinkered very badly. So they got a man from the B.C. electric company which supplied Vancouver and the lower mainland as PG&E does here, but with coal gas.

He recommended that to overcome clinkering they feed some hog fuel, which is essentially saw mill waste. By mixing that with the coal, it didn't clinker. But of course, the gas producer was built for coal and so it didn't have a large enough hopper to get the hog fuel into correctly. It was a very poor mess. I rigged up a little car that we could shovel full of hog fuel and then a little hoist so that we hoisted it up and you could therefore rake, say, a cubic yard of hog fuel into the furnace in maybe thirty seconds, instead of taking a couple of minutes to shovel it in. All the time that the thing was open, you were losing a great deal of effectiveness.

Swent: Did people who worked there also live there?

Fowler: Yes. There were I suppose maybe a dozen or twenty little houses. Then there was quite a crew in the boarding house.

Swent: The company maintained the houses?

Fowler: Yes. The company owned the whole place. They owned about 1300 acres as I recall it. All the roads on the place were private roads. Everybody was allowed to use them, but they did close them for one day every year so that they could keep them as officially private. The importance of that was that if you are using trucks on private roads, you don't pay gasoline tax. I think you have the same thing in this country. If you never drive your vehicle on a public road, you don't have to have licenses and you don't have to pay gasoline tax. You set up a gasoline station on your property. Anyway, that was the case there.

Swent: They must have had to bring in and take out a lot of things?

Fowler: Yes; that was an interesting thing about that. The company had its own dock, but like several parts of the plant when I went there, that was sort of falling down. We had to repair it so that one of the things that I said about the place was that we kept production coming out of a plant while we were revising it and we developed a new quarry while producing out of the old one. We hauled rock over a road from the new quarry while we were building it. We brought in supplies and shipped out product over a dock while we were rebuilding it.

Swent: What a challenge!

Fowler: It was a very, very interesting job. It was the first time I had been in the position of having a responsibility like that, so it was a lot of fun.

Swent: Do you recall what you were paid?

Fowler: I think \$325 a month.

Swent: That was pretty good then, wasn't it?

Fowler: Yes. It wasn't bad.

Swent: Your housing was provided?

Fowler: Yes. The housing was provided. I had a little more than that when I left Cominco but I had to pay rent. I don't think we paid rent at Blubber Bay. I don't really remember.

Swent: Did Kay enjoy it?

Fowler: Yes, I think she did.

Swent: How long were you there?

Fowler: Two and a half years.

Swent: Long enough to get the plant going.

Fowler: Yes. A lot of improvements were made there. There were some more contemplated but they weren't finished. But there were some interesting things about the job.

Trying to Justify Expansion of the Plant

Fowler: Our operation was perhaps--the quarry--maybe 180,000 tons a year, which is pretty small as quarries go. So everything was pretty high cost and we could barely compete for selling lime in the state of Washington and in Oregon with lime shipped by rail from Missouri. I kept trying to persuade the company to expand the plant so that we could get our cost down. The management was pretty conservative. The general manager said, "Well, you know, if we get into trouble, we can fire the crew, but we can't fire the plant." [Laughter] Of course, there were lots of people who got into trouble by investing too much in a plant.

Anyway, we had a geologist do some work there to get us out of a problem in the quarry because the quarry had some dikes in it. It had an overburden of limestone with high magnesium, which is unsuitable for most purposes for making quicklime. The geologist enabled us to understand the situation there. We did drill and open up a new quarry that was all in high-calcium lime. Then with that new quarry we were able to do better because the quarry that was there when I went was pretty deep. There were problems in it getting deeper. We had pretty steep sidewalls on it and so on. But the rock was pretty stable. After all, you get these enormous limestone caves and they are stable. So there are a lot of stable limestone formations.

Anyway, on the basis of the geological information we had, I calculated that on their company property there was somewhere around 500 million tons of high-calcium limestone. I said, "This is the first essential. If you want to expand a plant, first of all you have to have a reserve." The reserve here was so enormous that there was no question that you had a reserve to justify the expansion. After a couple of years, the management was getting tired of my prodding. The general manager came up one day and he said, "I want to talk to you."

He said, "Look, you've done a lot of good work for us, but I think you'll have to agree that it hasn't been a happy marriage." This was the end of August. "Why don't you plan to leave here by

the end of September and your pay will go on to the end of the year." This was by far the best termination I ever had.

Swent: It was decent, yes.

Fowler: It was very nice. Well, the pay wasn't very high, so it was kind of needed. Anyway, we did also put in a new power plant there. It was a diesel plant with good used diesel engines. But it was a very nice bunch of people and I certainly enjoyed it very much. I don't know if there is too much more that should be said about that.

IV PRODUCTION MANAGER, DENVER EQUIPMENT COMPANY, 1948-1950

Swent: So then you had to start looking around.

Fowler: Yes. As a matter of fact, I had already started. When I was working with Cominco, I examined a property in Oregon. The fellow that I examined it for got me an introduction to Mr. Daman, who was the owner of Denver Equipment Company in Denver. So I went down during a vacation and interviewed him and talked to a few of his associates. Then, about the first of October of 1948, we went down to Denver. That was a very interesting job for a couple of years.

Swent: What did you do for them?

Fowler: Well, I went there, supposedly as production manager but I was a lot of other things besides a production manager. It was interesting and it was nearly all directly concerned with the manufacture of mining and primarily metallurgical machinery.

Swent: What kinds of things were they making at that time?

Fowler: Well, at that time Denver Equipment made ball mills, and classifiers, flotation machines, and thickeners, and filters. And feeders, reagent feeders.

Arthur C. Daman, the Founder of the Company

Fowler: Mr. Daman used to come down to the shop periodically. I found him quite an inspiring individual. One of the things I remember particularly was his great emphasis on supplying spare parts in a hurry. Because he said, "If you've got a customer and his plant is shut down, he needs it in a hurry."

Another thing was these reagent feeders. He had some sort of a particular liking for them. He regarded them somewhat as an advertisement, I think. I remember his saying at the shop one

time--we had a bunch of them stacked up ready to ship--, "You know, we lose a dollar apiece on those things but, boy, we sure sell a lot of them." [Laughter]

Another thing that I've always remembered about him was how he would come down to the shop and he would get a hold of me and a couple of other fellows around the plant. "Now, boys, when you get an order in here for a spare part, by God, you ship it now." He went through that several times. I think that was a significant part of the success of that company, spare parts.

Swent: Had he founded the company? It was his own company?

Fowler: Yes, he founded it. On the importance of spare parts, I remember my dad telling me one time that somebody who used to sell Holman machines (they were made in Britain) in British Columbia where I was a boy always wanted to know why Dad wouldn't buy Holman machines. He said, "Well, you can't supply the spare parts." They had used Ingersoll-Rand and Gardner-Denver; those were the machines that were widely used at the time in British Columbia.

Another thing about Denver Equipment, their emphasis on service to the customer. They had a little publication about monthly called the DECO Trefoil.

Swent: I remember that.

Fowler: That used to have information about new plants and their flow sheets and so on. There was very comprehensive information in it, a lot of useful stuff. They also put out a couple of publications that in a sense were catalogues of Denver Equipment but a tremendous amount of information about mineral processing. I still have one of their little handbooks. I don't use it much now but I certainly have used it over the years. Not only information about machinery but you would find, for example, tables of various properties of all the common minerals. Very useful, useful book. I think he just gave those away to his customers.

Role of Equipment Salesmen

Swent: The salesmen were also purveyors of information, weren't they?

Fowler: Oh, yes. Very much so. I think salesmen of mineral industry and chemical industry equipment in general are good purveyors of information. I dealt with them particularly in later years, when I was with Mountain Copper Company. I always used to be delighted when a salesman would come around. The plant was a little bit out

of the way. These fellows would come around and I would always find an hour or so to talk to them, if they wanted to spend that much time, because it was very, very informative.

Swent: What did you call them in those days?

Fowler: Salesmen. Or sales engineers.

Swent: They have a fancier name now. I think they are called plant representatives or something.

Fowler: I wouldn't be surprised.

Swent: A company like Denver Equipment had heavy competition.

Fowler: Yes, they did. Dorr-Oliver was their principal competitor. When I went there, it was the Dorr Company. Oliver at that time just made filters, or filters and thickeners, I think.

Swent: So service was an important part of the way to compete.

Fowler: No question about it. A very important way. Then, I guess, a good half of DECO business was export. In 1950, the early part of 1950 as I recall it, there was a significant change in foreign exchange. That just meant that for quite a while, Denver's export business just stopped for quite a few months.

Swent: Where were they exporting to?

Fowler: All over the world. Oh, yes. But particularly, Western South America and Africa. Not very much in Europe; I would say very little in Europe.

Swent: Canada?

Fowler: Yes, Canada. But I don't think Canada was that much affected by the foreign exchange, and DECO had a plant in Canada. But South America and Africa certainly were affected, where they were dealing with largely British pounds. So the pound went down so that meant it cost you a lot more in pounds to buy Denver Equipment. People just didn't buy anything they could get by without for quite a long time.

Swent: How did this affect you?

Fowler: I think the suggestion came from Mr. Daman, as a matter of fact. I had a vacation coming up and he said, "I think you had better look for another job." And I did.

Swent: Because production was cut back.

Fowler: Oh, yes. Quite significantly. But it was a very interesting couple of years because we had shops, or that is parts of the shop, that did various things. We had a foundry and plate shop where they did a lot of welding to make, for example, the flotation machines. Then the machine shop and assembly. A lot of the stuff was made right there from scratch.

Managing the Assembly Plant in Denver

Swent: What were you doing?

Fowler: Actually, when I went down to Colorado Springs, which was the main plant--I spent the first part in Denver, or sort of ran the Denver assembly shop for a while. In Denver, DECO didn't do any machine work. It was really just an assembly plant. A lot of stuff was contract machined in Denver, but then DECO also had their plant in Colorado Springs where they had all the shops and manufactured things.

Swent: You were doing more mechanical engineering, would you say?

Fowler: Well, I suppose some of it was mechanical but the work was more a matter of organizing to see that supplies came in, because although we had a foundry, we bought a lot of castings. Seeing that the castings got to where they were supposed to on time. I did quite a bit of expediting. The engineering drawings for manufacturing stuff, a lot of them, while they were generally good, you would find errors. The foremen, when they would come across the error, they just changed something.

Assistant Plant Manager, Colorado Springs###

Fowler: At Colorado Springs, they sent a fellow by the name of Bob Mathers down there and made him plant manager. My work there was really largely as his assistant. When I found these errors in the drawings I would tell him about it. Then he had me mark up the drawings and then he would just put a little note on it and send it back to Mr. Daman. He didn't send it back to the chief engineer; he sent it back to Mr. Daman. Those things got fixed up so you didn't have to have the same error in the next go-around.

Swent: These production routines and so on, though, were already pretty well in place when you worked there.

Fowler: Yes, they were. Yes. I remember one thing. There was quite a bit of negotiating with employees and the thought of unionization. I think they avoided the unionization as I recall it. But Mathers came there about the same time I did. He had been a personnel man for General Motors.

A very interesting thing that I did there under his leadership was make up a job evaluation for every employee in the plant. That was a very interesting experience. I guess the pattern that he had me follow was probably developed by General Motors. You took into account such things as the hazards that are connected with the job, the responsibility for safety to others, the responsibility for accurate production work, the general quality, how difficult the labor was, how strenuous, and things like that. Also the fact that I went down and interviewed every employee with this form and got answers, including his reaction to it. It was a very interesting experience.

Anyway, we left there in the fall of 1950 and came out here. I spent a little time with Columbia Steel at Pittsburg.

Swent: Let me ask one more question about Denver. Was there any provision being made for a successor to Mr. Daman?

Fowler: Well, his son-in-law, Bill Allborg--I'm sure there was a period when Mr. Daman thought that he might take over, but I don't really think that Bill Allborg was the man for it.

Swent: It sounds as if it was very definitely a one-man show.

Fowler: It was very largely so. But three or four years later, Bob Mathers was down in Los Angeles on a job there. I was down there talking to him; I don't remember if I was looking for a job at the time or not. Anyway, I had quite a chat with him one day and I said, "Well, you know, Bob, when I joined Denver Equipment, I thought I saw the need for a general manager."

He smiled and said, "So did I." [Laughter] But neither of us got the job, as it turned out.

Anyway, I had no regrets about my experience there. It was generally very pleasant. We got to live in Denver for a year, or Littleton, which we enjoyed. Then we were a year in Colorado Springs, which was a delightful place to live. Certainly it was then. I don't know what it's like now. Population was 50,000 when we were there. We came through there fifteen years or more ago and it was well over 200,000 then. I find it difficult to believe that it could be as delightful now as it was when we were there.

Swent: It's still a lovely location.

Fowler: Oh, it is. There was an outfit making some advertising material. They wanted some musical background so Kay had a job with them for a while in providing violin music in the background. She enjoyed that very much. It wasn't very much but we were still pretty busy with the children.

Swent: How many children did you have?

Fowler: Two. That was the time Ken was just getting started in Boy Scouts. Helen was two years younger. I don't know if there's too much more to say about Denver Equipment.

Swent: How did you get out to California? Why did you come here?

Fowler: We looked for a job on a vacation. Just about that time, Kay's dad had had a heart attack so she flew out to Seattle to be with her folks for a little while. I drove out to Seattle and I looked at a couple of job things. One in particular I remember was phosphate in Idaho. Then I went on out to Seattle and spent a couple of days. I don't have any particular recollections of looking there. But Kay's brother was living in Menlo Park, so we drove down the coast. We spent a few days with Ed and Peg Moore and I did some looking here. I put in an application with Kaiser but didn't find anything, and one with Columbia Steel. They were just starting a fairly big expansion project there and so I got in on a construction project.

Swent: Where was that?

Fowler: At Pittsburg, California. It was very interesting and provided an opportunity to learn a lot about both construction and operation of steel plants, but I didn't visualize there being too much future there. So I sort of started looking for something else fairly soon after I got there. From there I went to work with Kaiser.

V ENGINEER FOR KAISER COMPANIES, 1951-1961

Plant Superintendent for Kaiser Magnesium

Swent: Kaiser Engineers?

Fowler: No. It was Kaiser Magnesium, a subsidiary of Kaiser Aluminum. They called up one afternoon. When I got home, Kay told me so I called them back. This was at Manteca. The magnesium plant was one that had been operated in World War II. They decided to reopen it for the Korean War. There were three main parts: there was the raw materials preparation part; the furnace, or reduction plant; and the foundry to put the magnesium into a form that was good for shipping.

Anyway, I called back to this place about six o'clock and they said, when would it be possible for me to come over for an interview.

I said, "What about this evening?" I talked to a fellow by the name of Harley Phillips.

He said, "Well, that's fine. When can you be here?"

I said, "I can get there about eight o'clock, something like that." So I did. I met him. He was the general superintendent and a fellow by the name of Don Fowler, no relation, was the manager. They took me out through the plant and so on.

Making Metallic Magnesium at Manteca, California

Fowler: The plant was the Pidgeon process, or a ferro-silicon process for making metallic magnesium. You take the raw materials, which were ferro-silicon and calcined dolomite, dolomite being calcium-magnesium carbonate. When you calcine it, you get calcium-

magnesium oxide. You grind these raw materials so you can get them intimately mixed, then briquette them. Then you put them into a furnace. The briquetting was done in briquetting presses, which were rolls that, as you fed the stuff into the top of the rolls, they were subjected to very high pressure and the roll shells had indentations in them which formed the briquettes.

So after we had gone through the plant we went back in the office to chat for a little bit. Harley Phillips said, "How much experience have you had with high-pressure briquetting presses?"

I said, "This is the first time I ever saw one."

He said, "Good. You're hired." [Laughter] That was the shortest interview I ever had, I think. But I guess they concluded that I was adaptable enough to be able to handle it.

Swent: Where did the magnesium come from?

Fowler: From the dolomite. Kaiser had a quarry at Natividad. I think the calcining plant was at Natividad. They had already started their sea-water magnesia plant, which was at Moss Landing. If you take dolomite, which, as I say, is a mixture of calcium and magnesium carbonates, and you calcine it to the oxide and then react it with sea water, the sea water contains magnesium and in that reaction, the calcium goes into solution and is replaced by magnesium from the solution in the sea water. You start out with half calcium and half magnesium, and you end up with all magnesium as oxide. You can make a very, very high purity magnesite that way. Then that was used in the manufacture of refractories. They had the wherewithal all ready to use in this Natividad plant to make raw material for the metal. They had operated it during World War II. Part of it had been idle in the meantime.

Swent: Were they selling it to Kaiser Refractories then?

Fowler: The magnesium?

Swent: Yes.

Fowler: Oh, no. Kaiser Refractories got its pure stuff from this same plant, or rather they got the dolomite and took it to their sea water plant at Moss Landing. Then we got some of the dolomite that had been calcined there at the same plant that they were using, and hauled it by truck about 100 miles to Manteca. They had a ferro-silicon plant at Permanente. That had been built during World War II. So it was really a matter of reactivating the magnesium plant. There were a few problems with it that had been problems before, I guess, that we had to overcome. It wasn't any major thing.

It was largely a matter of a bit of organization and getting a crew working together. Working around the clock 168 hours a week. We had four crews, each of whom worked 42 hours a week. That's pretty much a standard thing on plants you have to keep going continuously.

Swent: What was your specific responsibility?

Fowler: I was responsible for the operation of the plant that received, stored, ground, and blended the calcined dolomite and ferro-silicon and briquetted the mixture. The briquettes had to be bagged in paper bags for charging into the furnace.

Swent: The furnace came next?

Fowler: Yes, that followed. But just briefly, it was an especially designed furnace and a pretty expensive process, but the advantage of the Pidgeon process is that there is virtually no risk of explosion, as there is in other methods of making magnesium. I don't know that much about the other methods, but in order to work this, you put the briquettes into a tube in a furnace. It was a stainless steel tube about eight or possibly ten feet long that was in a furnace, and then at the outside end of it, after you charged the furnace with the raw material, you clamped on a cover that had a condenser in it. I guess it was water cooled. I don't remember for sure, but when you put that mixture into the furnace and heat it to a fairly bright red heat, the ferro-silicon reacts with the dolomite and forms a calcium-iron silicate. The ferro-silicon acts as the reducing agent, reducing the magnesium oxide to metal. The temperature is high enough that the metal vaporizes, so it becomes a fuming process. Then as the vapor is given off it migrates to this cylinder on the end where the vapor condenses in this cooled part that is outside of the furnace. When the tube has finished "cooking," you disconnect the cylinder and put it into a press and press out the magnesium. This is a piece, as I remember, maybe eighteen inches long and ten inches or so in diameter, as a more or less solid block. It crystallizes in there and there are some void spaces and loose, small crystals.

One of the interesting things about it is that you have to have a pretty darn good vacuum. Essentially one hundred microns absolute pressure. That's a tenth of a millimeter of mercury pressure, as compared to the atmosphere, which is 760 millimeters. If the pressure gets as high as 200 microns, the process just is completely inoperable. So it wasn't my responsibility, but the operation of that furnace, to keep a high-temperature furnace and everything else, and keep it that vacuum tight, it was pretty tricky.

But it did work. It was practically free of any accidents. A lot of stray small crystals could under some circumstances result in spontaneous combustion. So they took all the furnace product to a foundry where they melted it and then poured it into pigs like you do lead or zinc. You pour it into pigs to ship it. I didn't, again, have anything to do with that, but I think you have to melt and pour the stuff maybe under nitrogen or something of that sort so that it won't ignite when you're doing it.

Swent: Magnesium is not very stable, is it?

Fowler: Well, it's very easily oxidized. If you take magnesium powder, well, that's used in flares. I think the main reason they wanted the magnesium for the Korean War was for incendiary bombs.

Swent: What about safety in your end of it, in this plant?

Fowler: As I recall it, we didn't have any accidents. Certainly, Kaiser put a lot of emphasis on safety. We would have staff meetings once in a while. There was usually some discussion of safety. I always remembered one of these. There weren't very many people driving cars around the plant. As I said, Don Fowler was the manager and Harley said at this safety meeting, "There have been some complaints recently about people speeding around the plant. The main complaints are about Phillips and Fowler." But I don't recall any serious accident in the few months that I worked there.

Kaiser Aluminum & Chemical Corporation; Superintendent of a
Fluorspar Mine, Fallon, Nevada

Fowler: I went to Manteca about the first of June, 1951. We got the thing operating pretty smoothly and then one of the foremen was able to take over and I was sent about February of 1952 to open up a fluorspar mine that they had bought near Gabbs, Nevada. This brings to mind a remark of Hawley Phillips. "You can't get promoted if you don't train someone to take your place."

In the manufacture of aluminum, in the original process, you put alumina, in other words aluminum oxide, into a furnace, in a bath of molten cryolite. That's a mineral that was available; I don't think it's ever been produced commercially anywhere except in Greenland. Cryolite is, if I remember correctly, sodium aluminum fluoride. By that time most plants were using at least some artificial cryolite. Then you have to keep putting in makeup of this stuff, but you can keep the thing going fairly successfully, once you get it started, by adding sodium fluoride.

Kaiser was buying sodium fluoride, but felt they were getting stuck for it. So they decided to put in a plant to manufacture it. Or at least they had General Chemical Company build it. Then in order to cut down the cost, they decided to get in their own fluorspar mine. They bought an existing mine at Gabbs, Nevada. It wasn't in operation but it had operated previously, so they bought that mine and they sent me over to put it into operation. We got that going to make what's called acid-grade fluorspar. I think it's about 97 percent.

The mine was out in the desert and we couldn't find a source of water there. We did have a small well at the mine for domestic purposes, but we decided there wasn't much chance of getting what we needed for milling. So we hauled the ore into Fallon, Nevada, and built the mill there, where it was right alongside the Truckee River.

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Swent: How far was the mine then from your mill in Fallon?

Fowler: As I recall it, it was a seventy-mile truck haul. The plant at Fallon was on the railroad so we were able to ship out without any problem.

Swent: Did you have to get involved in planning the trucking too, then?

Fowler: I was there as general superintendent.

Swent: The mining and the milling and all.

Fowler: Yes. It was quite a small operation. I've really forgotten but I think the mill operated at about 100 tons a day. Then we made, as I say, acid-grade fluorspar which we shipped to General Chemical Company, who at the time had a plant in the Bay Area. Somewhere near Antioch, if I remember rightly.

Swent: What particular challenges are there in mining fluorspar?

Fowler: The key requirement is that acid-grade must be 97 percent CaF_2 . It was an unusual deposit which allowed really very simple metallurgy. But it was small and low-grade so the challenge was to get enough production out of the mine to keep the mill running. The original prospector by the name of Vet Baxter had hand-sorted and shipped direct. I think he shipped acid-grade, so he had some fairly good-sized waste dumps. I don't remember how big, might have been 20,000 or 30,000 tons. We shipped a lot of that to Fallon to start the mill up because we had to do quite a bit of

development underground in order to get the mine so it could produce.

Swent: Why was it economic for you to use it where it had not been for him?

Fowler: He didn't have a plant and he was a very small operator. He didn't have the capital to build a plant. I think it was several years since he had last operated it when Kaiser bought it. It was economic for Kaiser only because when they had their own supply, then people weren't going to stick them for too high a price for acid-grade fluorspar.

Swent: So it was economic for them but not for a small operator.

Fowler: Yes. The mine did operate for several years. I don't remember how long because I was only there about a year.

Swent: What sort of milling operation was it?

Fowler: A flotation mill, grinding and flotation, plus filtering and a dryer because the stuff had to be down to practically zero percent moisture for use in the process that General Chemical had, to make the aluminum fluoride.

Swent: Did you buy Denver Equipment?

Fowler: Yes. [Laughter] Yes, we did. Incidentally, Ed Hassan, who was my boss just after I left there--I moved from there to Oakland and worked in the aluminum raw materials department--Ed was my boss when I moved to Oakland. He had worked for Denver Equipment Company. I think they had supplied some things at some other plants that Kaiser had. Anyway, they did supply practically all the equipment except, I think, the dryer. It was a rotary dryer, like a little rotary kiln. At that time I believed a number of U.S. fluorspar mills used DECO equipment.

Swent: Did you move your family out to Fallon?

Fowler: Yes, and we enjoyed it there. We had bought a house in Manteca. I guess we were fortunate to be about the first of the staff to leave Manteca because we were able to sell the house and do fairly well on it. At the end of the Korean War--the main fighting over there was fairly soon after that--they shut the plant down at Manteca and I think a lot of people had quite a bit of difficulty in selling their houses.

Then we thought of building a house in Fallon. We rented when we first went there. As I recall it, we bought a lot but we never got around to building on it.

Swent: Was Fallon expanding a lot at that time?

Fowler: Not very much.

Swent: It's a big air base now, isn't it?

Fowler: The air base was already there. That was going pretty strong. That was during the Korean War and it was going strong when we were there. I don't know how big it is now. I really have no idea. That was pretty much that.

Swent: Then Kaiser moved you from there to--?

Fowler: To Oakland, yes.

Swent: That was at their initiative, was it?

Fowler: Yes. Both those moves were at their initiative. I was under the impression then that all staff--and line--moves were at Kaiser's initiative.

Swent: Were you still with Kaiser? All these Kaiser companies, did you move from one to the other?

Fowler: Yes. It was Kaiser Magnesium. Then it was Kaiser Aluminum & Chemical Corporation at Fallon. It was Kaiser Aluminum & Chemical Corporation in Oakland. There, I was working on various things in relation to the supply of raw materials for the manufacture of aluminum. The main thing is bauxite. I didn't do very much in bauxite because they had a fairly good reserve in Jamaica. But they were still looking to expand the reserve. I looked at several fluorspar deposits because, of course, the fluorspar is an essential raw material.

Exploring for Aluminum Phosphate in Florida

Fowler: Among other things, we looked at the wavellite deposits in Florida. Florida, as I expect you are aware, still had very large deposits of pebble phosphate; that is, essentially, tri-calcium phosphate. Much of the pebble phosphate deposits were overlain by ten to twenty feet of clay-like material that is essentially wavellite, which is aluminum phosphate. That cannot be economically treated in the process by which they handle the calcium phosphate, because the aluminum phosphate is insoluble in acid. But we examined that because we wanted to see if we could

recover the alumina from it. Of course, if you could recover the alumina, you could also recover the phosphate.

We had arrangements with several of the phosphate companies with the thought that when you're preparing to mine the calcium phosphate, you strip off a layer of sand and then you could strip off the layer of aluminum phosphate and process that. We found that there was a pretty large potential reserve there and it was possible to treat it, but it just seemed that because of the cost of the plant that it wasn't economic to do it. So that project was dropped.

It always seemed a shame to me that it had to be that way, because here was this significant reserve of both aluminum and phosphate, but the way they operate the phosphate mines now, they strip that off and they mix that up with the overlying sand. Where it might have been almost economical to handle the separate layers as you went, you would have to be awfully hungry for phosphate before it would be possible to go back and handle the mixture in years to come. Anyway, that was an interesting thing to investigate.

Swent: Were there environmental concerns at that point about this kind of stripping?

Fowler: Yes, very much so. That concern was recognized by the companies operating the phosphate then because the processing results in a lot of clay--waste material--that settles very, very slowly in water. So that when you put it in mined-out pits, the waste from the flotation and other plants processing the phosphate, it means large areas of ponds that are more or less useless. They have done work on trying to figure out means of handling it. I think they have made quite a bit of progress. I don't know the situation now but I do know that it is still a very significant problem.

Searching for Bauxite in Hawaii

Fowler: Anyway, we gave that up. Then I was back in Oakland for a little while. Bob Dreyer, Dr. R.M. Dreyer, had been in Hawaii during World War II in Naval Intelligence. He became interested in the possibility of finding bauxite in Hawaii. In 1956, as chief geologist for Kaiser Aluminum, he persuaded them to investigate this. So I went to Hawaii to carry out the program that he recommended and specified. That was certainly an extremely interesting assignment. I was actually on three islands every week for a year.

Swent: What a tough assignment. [Laughter]

Fowler: Yes, really tough. It was hard work but it was delightful. I enjoyed it immensely. In many respects, the biggest drawback was that when we started, we had no idea how long it was going to be or anything, so I left the family in El Cerrito--we had bought a house there.

Kauai

Fowler: Dreyer figured that the most important place to look was on the island of Kauai. That certainly is where the most economic material was. We had to negotiate with the plantation owners because most of the good material was on either sugar or pineapple plantations. We were able to negotiate exploration rights with them, but we never actually got to negotiating mining rights. But on Kauai, the bauxite--. I say bauxite; it isn't technically bauxite, because it never turned out to be economic. It wasn't very far from it.

It's on places where there had been flows, that is, volcanic flows of melilite basalt. This has a composition such that when the basalt weathers, you fairly quickly (that is, quickly geologically) get rid of the silica and convert the alumina that's present to essentially gibbsite. Gibbsite is the most desirable mineral in bauxite. Bauxite in many parts of the world is a mixture of gibbsite, which is alumina trihydrate, and of alumina monohydrate. But the trihydrate is much easier to process.

The deposit on Kauai was essentially nodules of gibbsite in clay. We explored much of the portion of Kauai that had any potential on it. There was an area on the Kilohana Crater near Lihue which was, as I recall, the most favorable, but there were several other areas. There was an area on the Princeville Ranch that is sort of the other extremity of the island as far as the bauxite potential is concerned. Then there was a lot of area in between, both sugar plantations and pineapple plantations, and there was a fair amount owned by small landowners besides the big plantations.

We got rights to explore all of this. The stuff is essentially in clay so it's easy to drill. We used hand augers. We drilled several hundred holes for a total of 43,000 feet. Depth varied up to forty feet, but averaged about twenty feet. We set aside two feet as top soil; average depth of ore was 13.2 feet. All told we ran about ten thousand analyses. We established a laboratory there.

Swent: When you say hand drilling, you're actually cranking a drill?

Fowler: Well, it's an auger to which five-foot lengths of steel pipe are added as required and a Tee-handle on top. Then you just turn the drill like this [demonstrates] by hand like a giant corkscrew. A little bit of pressure is needed, but the auger is made so that it tends to dig itself in a bit if the stuff isn't too hard, and most of this was not.

We had a fellow by the name of Art Heuck who was in charge on the island of Kauai. He did a wonderful job of organizing the field work. Jack Sarradet was in charge of the lab. He had worked in the company lab at Baton Rouge, Louisiana, where Kaiser had one of their large alumina plants. He established the laboratory. We bought about \$20,000 worth of equipment to set it up. We were able to rent a couple of quonset huts that had been used during the war for something. We established the laboratory in that and also an engineering office to handle the field work, mapping and reserve calculations.

So we got this information from all these drill holes and worked it all out. As I recall it, there is on Kauai about 32 million tons of available alumina, half of which was easily recoverable at plus 80 mesh. The other half was very fine material and we did no testing on recovery.

A Tsunami on Kauai

Swent: You had mentioned an experience with a tsunami on Kauai.

Fowler: One morning I was having breakfast at a motel on Kauai when I was called to the phone. Jack Sarradet said, "The police just came by and said that a tidal wave will hit the beach here in about two hours." I said, "Load the balances, key equipment and maps into a car and leave." He said that he couldn't do it alone. "Where's your crew?" "Man, they're gone." I asked again how long it would be and said that I'd be there shortly. Art Heuck arrived soon after I did and the three of us loaded key items into three cars and headed for high ground overlooking Lihue harbor to watch. The harbor had perhaps a square mile of space inside a breakwater. As we watched, the ocean level dropped two to three feet and water rushed out between the ends of the breakwater. Then from the low it rose probably five or six feet.

As we watched I realized why this was called a tidal wave. The normal high tide at the equator travels around the world in

two waves per day, each at about 1,000 miles per hour, frequency one every twelve hours, wave length 12,000 miles. In a similar manner a "tidal wave" travels only 500 miles per hour but the wave length, per my faltering memory, is about 40 miles and the frequency is roughly 12 per hour. In other words, in this case the effect was like a tide rising five feet into two and one half minutes. Thus it is easy to imagine the enormous currents a tsunami can cause at the narrow entrance to a harbor. At Hanalei Bay at the north end of Kauai, the water rose to a height of about thirty feet, the configuration of the bay having a major influence. The waves continued to rise and fall every five minutes to gradually decreasing heights for more than twenty-four hours. It was an awe-inspiring sight.

Hawaii

Fowler: Then we also did some work on Hawaii. We didn't drill that nearly as completely, but the material is much more uniform over a large area on Hawaii so we could get an estimation by taking patches here and there and drilling those patches. We drilled holes at maybe 2,000-foot intervals. It was amazingly uniform. There, the deposit was an alteration from a volcanic ash that had been laid down pretty uniformly. Slightly the best material was on the sugar plantations but above the sugar plantations there is some forest, much of which is the Hilo watershed.

So the result of the program was that we estimated that there were about 200 million tons of available alumina on the island of Hawaii. Incidentally, this is in clay. I don't remember now what the type of clay is, but it has a property in its crystalline structure that it is extremely porous and therefore has a very high water content, sort of as moisture, but still it can support cane harvesting machinery. When we dried samples at 105 degrees Centigrade, we found the stuff was in the range of 40 to 20 percent solids, and the rest of it water. Which is quite amazing.

Another surprising thing to me was the rate of weathering under wet tropical conditions. I visited a lava flow that had occurred only two years before. Ferns were already growing on it.

Testing a Reclamation Program

Fowler: We had quite a small crew over there because we were doing relatively little work. In the forest area, we had to cut some trails to be able to get into them. One of the things about this project is that we had planned, partly on the basis of experience in Jamaica, that we would set aside two feet of material as topsoil. So we didn't even analyze that. We would just drill down to two feet without taking any sample and then from there on down as deep as we found the material went. The thought was that by setting aside the topsoil, and then mining the material that had the bauxite in it, and then putting the topsoil back, that you could go back into the crops they were growing before.

To test this out, we selected an area on Kauai where the bauxite layer was only five feet thick. After we worked to select the area and to set up the program the U.S. Bureau of Mines carried out some tests. They stripped off the topsoil and stockpiled it. Then they removed and set aside the bauxite. Finally, they put the topsoil back and then grew crops. I think these crops were largely grass-type materials and so on. Anyway, the crops grew significantly better in that reclaimed land than they did on the original ground.

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Swent: That must have been a happy conclusion to reach.

Fowler: Yes, it was. In that connection, there's an interesting thing that I've been studying a bit lately. As a result of acid rain and so on, where there is damage to forests, they're finding that the forest damage due to acid rain actually results from the fact that the acid changes the composition of the soil and leaches out some of the essential nutrients and also because of the presence of acid, you can get a certain amount of aluminum into solution in the soil moisture. That is, any plant picks up its mineral nutrients from soil moisture, essentially.

It seems that taking up the desirable nutrients is a matter of ion exchange on the root hairs. The ion exchange works on a basis that ions with a high valence--aluminum has a valence of three--tend to displace from the ion exchange sites those with a lower valence such as essential magnesium and potassium. For that reason, if you get a lot of alumina in the soil in solution, then it tends to sort of poison or prevent the needed elements from getting there. That presumably is why the crops grow better on other soils than they do on bauxitic soils.

The above comes to mind because friends expert on studies relating to acid rain have recently been investigating the island of Hawaii. It seems that a lot of trees are now dying in the rain forest on the Hilo coast of the Big Island. When we worked there, that area was subject to 300 inches of rain per year and was one of the densest tropical forests anywhere.

Another little sidelight on that was that the very important bauxite deposits on Jamaica were discovered because an English owner of some land, I think it was a sugar plantation, but anyway, his plantation wasn't very good. He asked an agricultural chemist to try and determine why it wouldn't grow good crops. This chemist did and said that he thought that it was because of the very high alumina content in the soil. "In fact, it is so high that I think you should approach some of the aluminum companies to see if they can use it." Alcan was the one that started it.

Another little sidelight, when we were looking for bauxite in Hawaii, Alcan decided to at least take a look at it so I met Roy Hose, who was the chief geologist for Alcan. He told me that he had seen letters written just after World War I in which some Alcoa geologists had gone to Jamaica and sent samples to Pittsburgh. Roy had seen the letters in which the chemists at Pittsburgh had said that this stuff wasn't worth analyzing. [Laughter] And so some things go.

Swent: You said you were working on three of the Hawaiian Islands.

Fowler: Well, we did a fair amount of work on Maui. I think there is some potential there on the northeast coast. It's the northeast coast in all islands, which is the windward side, where you get the heavy rainfall from the trade winds. We had an office in Honolulu, so I had my headquarters there. Most of the bauxite work we did was on Kauai; the next most intensive was Hawaii. We also had a little bit of a look at Molokai and a fair amount of Maui and some on Lanai.

Swent: None on Oahu?

Fowler: No. I did some personal sampling on Oahu but any place I sampled was no good. Also it would have been the most dense population and much the most difficult land negotiation problems if we had been able to go ahead. Because of the work of the Bureau of Mines, I think we could have persuaded the plantation companies to perhaps negotiate something that would be reasonable for all concerned. But an interesting thing: among others, there was the problem of disposing of the waste clay material. There were areas that were not cultivated where we had thought we could dispose of it. I'm not convinced that it couldn't have been dumped at sea if it was put out, say, a hundred feet below sea level.

Certainly there are mines in North America that dump stuff below sea level or in lakes. There is a mine that did operate for years at 30,000 or more tons a day on Vancouver Island; that was all put below sea level. The program of disposing of it was, and I think probably still is, monitored by the University of British Columbia to keep track of it. They don't seem to be concerned about it. For that reason, I felt it might have been successfully disposed of at sea. Maybe it couldn't have been but I don't really know why not.

Swent: You couldn't put it back where you got it?

Fowler: The thing is, you could put some of it back.

Swent: You have to store in the meantime.

Fowler: The thing is, in order to find places that are level enough to be able to store--. All these deposits are sloping, maybe a 10 percent, no, maybe a 3 or 4 percent grade. But then the stuff, when you're processing it wet, is going to run all over the place. So anyway, there was a problem.

But another thing, too, was that we figured that it was on the verge of being economic to ship that alumina trihydrate, the product we would make there, to Tacoma, where we had a reduction plant. Also there was a reduction plant near Spokane. You had pretty cheap sea transport. One problem, of course, with sea transport is that that would have to be on American ships, which are more costly than foreign ships. Anyway, it did look on the verge of being economic.

But about that time the Consolidated Zinc Company in Australia decided to diversify. They sent a crew out to look for petroleum. They went looking for petroleum up in northern Australia on the Cape York Peninsula. They found the Cape York deposits of bauxite, which are certainly among, if not the, largest deposits in the world. That changed the economics completely.

That pretty much covers that. An interesting little side story. We had a lot of legal work to be done there by Dudley Lewis, who was the principal owner of the firm that did our work. I mentioned Art Heuck being in charge on Kauai. He was married and had a daughter. There was only one good school in the territory at the time and that was Punahou in Honolulu. So Dudley Lewis was a graduate of Punahou and I guess maybe Harvard. I don't know where he went to law school.

Anyway, we were talking to Dudley one time. Art said, "Is there any way I can get my daughter into Punahou?"

Dudley says, "I hate to tell you, Mr. Heuck, but it would be easier for me to get you into Heaven than to get your daughter into Punahou." [Laughter] About two weeks later, one girl was caught smoking on the campus, and Alice got into Punahou.

Swent: There was a vacancy.

Fowler: There was a vacancy because one girl was caught smoking on the school grounds. They certainly had a reputation for very strict discipline on the campus. I never really heard any severe criticism for their discipline.

My family was here in El Cerrito most of the time I was there, but in July of 1957, the company was looking at this project pretty optimistically and they said, "Well, we think this is going to be permanent. You had better sell your house in El Cerrito and move over to Hawaii."

We got over there on the fifteenth of July. In the middle of September, they said, "Well, we're going to stop this and we want you to get all the reports completed and all the work finished and get all your crew, that is, all your mainland crew, off the island by the end of the year."

That ended it, but it was very nice being over there for a little while. Ken and Helen were in Punahou. I had made applications probably back in May or so; they were able to get into Punahou for the time they were there. We certainly enjoyed it. We didn't get around very much, but we did get the family over to Hawaii for a couple of days one time, just for a weekend I think, and we went over to Maui. We weren't working on the Big Island at the time but we did get over to Maui while we were doing some work there. I did take Kay to the "Garden Island" of Kauai on one trip. Another thing provided a little diversion for her there. She played violin in the Honolulu Symphony Orchestra.

Swent: How did you travel between the islands?

Fowler: Flying. As I say, I was on three islands every week for a year. On a few of those times, I managed to get some gloriously clear days and got some pretty nice photographs and so on. But it was a very pleasant experience, even though it didn't eventually lead anywhere. That took us to the end of 1957.

Searching for Bauxite in India

Fowler: Then I didn't know if I was going to have a job for a little while. Kaiser was working on a construction project to enlarge a steel plant in India, and got interested in setting up an aluminum plant in India in cooperation with Birla. Birla was the second largest private industrial firm in India. The first thing they had to do was find a source of bauxite in India. They had somebody go over ahead of time and select an area to work in. One of the thoughts was that of course, for making aluminum, you need cheap power. There was a dam under construction at a place called Rihand. So they picked a potential bauxite area that was a reasonable distance from the Rihand Dam.

I was sent over to find a reserve of bauxite. This was to be on the Amarkantak Plateau, which is interesting from a few points of view. The Indians place a great deal of religious significance on rivers. Amarkantak is a central highland, about 3500 feet elevation. The Amarkantak Plateau is at the headwaters of three rivers: the Mahanadi flows easterly into the Bay of Bengal, the Narmada flows west to the Arabian Sea near Bombay, and the Son flows north to join the Ganges. It was considered a place of religious significance at the headwaters of the these three rivers. This plateau is a remnant of the very large Deccan basalt flows that had originally covered an enormous area. This plateau, as it remains, had been eroded so that it was a very irregular in outline.

Then, around the edges of this, you have a more or less vertical drop-off, just quite short, maybe twenty to a hundred and fifty feet high. Obviously when you get an outline like that, you have very good drainage in that part of it. One of the significant things in the formation of bauxite is the passage of a great deal of water and in a moist climate. Good drainage is considered a powerful asset in the formation of bauxite. The Geological Survey in India had determined that the bauxite in this region was confined to a zone one hundred feet wide around the edge of the plateau.

A geologist from Pechinay--that's the French bauxite and aluminum concern--had been out there and he had been shown some deposits of bauxite around the edge. There are patches of some beautiful material, beautifully high-grade bauxite around the edge. He had presumably seen these and concluded that they went most of the way around the edge and that there must be some very enormous quantity of bauxite.

To conduct exploration, we had to establish a laboratory. George Huffaker from Baton Rouge came over with me to do that, the

only other American on the project. The closest place with the required reliability of electric supply was at Satna, about 200 miles distant by rail. Birla had a cement plant under construction there, and that is where we sited the lab. To get the samples there quickly and reliably, we had a courier ride the train and carry the samples. Huffaker hired and trained a staff of Indians, all with master's degrees in chemistry. Incidentally, not one had ever used an analytical balance.

Anyway, when we got there and started exploration by drilling, and a little bit of test-pitting work, we found that, yes, the deposit did seem to be confined to an area one hundred feet wide. Actually, it was only fifty feet wide. Then we found that instead of being continuous, you would get a zone maybe three or four hundred feet long. Then you would go a couple of miles before you would find another one. It was really very much restricted.

This was about the beginning of the monsoon and Kaiser had decreed from Oakland that we must do exploration through the monsoon season. They were anxious to time exploration to fit into expected completion at the Rihand Dam. It was very critical to get there in time to get started before the monsoon started. Anyway, we were going out to look at one of these farthest deposits one day and on the way, I noticed a few boulders on the surface of some land. Well, it's a little unusual in this situation to find boulders; it wasn't glaciated. I stopped and looked at some; I thought it looked interesting. I kept a couple of little chunks. We tested them for combined water when we got back; that seemed pretty good.

Well, this was right in the center of a large plateau area. We had decided, as I recall it, the initial plant was to be twenty tons a day of metal. Then we were to get a reserve for twenty years and a certain amount of bauxite. Well, the bauxite varies a great deal in its character. So I recommended to Bill Fisher in Oakland, who was in charge of the project, that we should aim to find a reserve of a million tons of available alumina, and that was approved. Well, this one deposit that we hit on by accident had something over 900,000 tons of available alumina in it, so that was where we did nearly all of our work.

Some time along in the project, somebody sent us a sample from another area. We had that analyzed at the lab and it was pretty good so I decided I should go and examine the deposit. This was one that was in operation. People were producing and I don't know really what they were doing with it, but the way they were operating, they piled up some stacks of bauxite by hand-sorting and shipped it.

Anyway, I spent one afternoon and the next morning on this deposit. I wrote about a one-page report in which I said that it was quite obvious that the deposit there was better than the one that we had spent a half million rupees exploring, and that it was clear that the owners of it were in a position to enter into a long-term contract. The net result was that the company bought that property. It was, as I recall it, a shorter shipping distance to the Rihand Dam. They did ship enough out from Amarkantak to be able to make good the leases that we applied for there.

Swent: What about these boulders that you found?

Fowler: Well, they were just a surface expression of this fairly large deposit, large in respect to anything else that was there.

Indian Assistants

Fowler: We had a crew of maybe forty people working there, I guess. I don't remember for sure. We had several people who spoke good English. The language there in general was Hindi. Then, besides Hindi, there are many dialects. When I was there, India was placing a great emphasis on making Hindi their universal language. This was fairly shortly after the independence, and I can certainly see logic in that, and perhaps it had enough similarity to some of the dialects that it also made a lot of sense. I emphasized to the staff that while that had its good logic, there was also the fact that where they could use English, they could communicate with people in Australia and Canada and the United States and England. It wasn't a good language because it was English; it was good because you could communicate with people all over the world.

A fellow by the name of Shukla was a trained geologist and was my main assistant there, a very pleasant fellow and quite competent. A friend of Shukla visited me recently. We discussed English and he said, "English is becoming the unifying force in India." A fellow by the name of Dutta was with us as a surveyor, a very young man at the time. He had been working at the construction plant that Kaiser was on in Jamshedpur.¹

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¹For more information on Kaiser in India, see James V. Thompson, Mining and Metallurgical Engineer: The Philippine Islands: Dorr, Humphreys, and Kaiser Engineers Companies: 1940-1990s, Regional Oral History Office, University of California, Berkeley, 1992, pp. 22-32.

Fowler: Dutta, as I say, was very young and had tremendous enthusiasm and so on. Then, before we left, we hired another geologist by the name of Kale. He had just got a master's degree and this was his first job.

Swent: Did they train in India?

Fowler: Yes. All trained in India. Interestingly enough, I've been able to keep in touch with those three fellows since. Dutta was very anxious to come to the United States. In fact, all of them were; they wanted me to sponsor them but I didn't feel financially able to take the responsibility. Anyway, Dutta ended up on his own getting to Vancouver. At that time, there were arrangements within the British Commonwealth for people to transfer pretty readily. So he got to Vancouver and I was able to get him his first job there with a former classmate. He has since done very well. He worked on a lot of projects in Canada and eventually got working up around Edmonton somewhere with a firm from Los Angeles. He has worked with them ever since. They've brought him down here to the States; he's an American citizen. His last job for them until a couple of years ago was five years in Kuwait. Fortunately, that ended when it did.

Kale, after that job, went to work for an iron ore company. There were several fairly large iron ore producers in India. Then he got himself to Australia and is now chief geologist for the Mt. Newman Mine, which for several years was the largest producer of iron ore in the world, shipping as much as 36 million tons of high-grade iron ore to Japan in a single year. We still keep in touch with him. He's been here; Dutta's been here several times, and Kale's been here twice. Shukla is now retired, living in Jaipur. He worked for a long time for the Geological Survey of India. We still hear from him once every year. It's been very pleasant keeping in touch with all of them.

Impressions of India

Fowler: A couple of the impressive things about India. One is the tremendous background of high-quality artisanship that you find among a good proportion of the people there. India has done wonderfully well in increasing the production of food with certainly a lot of foreign aid, in terms of financing a number of dams. India has been, until recently, when they got those dams built, a land literally of very much feast and famine, depending on the state of the monsoon and how much water they had to irrigate anything with, or rather just depending on rainfall, as compared to now being able to irrigate.

You can't help being impressed by the tremendous poverty that there is in India. I gather from talking to people recently, there still is. The greatest tragedy to my way of thinking is that, since I was there, the population of India has increased by more than the total population of the United States today. I don't know what the outcome of it is going to be. It's hard to see that it won't eventually be a disaster in some form of starvation, if nothing else. They of course did have starvation very commonly in India but, as I say, in recent years, their improvement in agriculture, particularly resulting from irrigation, has made a tremendous difference.

Swent: Those numbers are just inconceivable, though, aren't they.

Fowler: Yes, they are. I think the numbers mean almost more if you refer to the total population of this country today than to deal with actual numbers. I don't know; you can't help feeling a little depressed about it in a way.

When I was there--I took my wife and daughter when we went. Ken stayed here to finish high school and then he came over for the summer. Then he and Helen came back together to go to school here. Helen did correspondence school there. So they went back to school here in the fall. When they left, Kay came out in the jungle with me. I think she had some pleasure in it, but it was also a very lonely life because there was only one other woman who could speak English and she was three miles away. Kay took a bunch of books with her. When she came up there, it was supposed to be the end of the monsoon, but the monsoon lasted another month after that. It was pretty miserable because she couldn't go anywhere from the little building a few of us lived in. She did do a lot of report typing for me but it was a pretty boring existence because there was so little to do.

I was out in the field long hours. I think on average I worked well over seventy hours a week.

Swent: Did you stay healthy?

Fowler: Pretty much so, yes. I got a bad dose of dysentery early on, but was able to get some medicine and got over it fairly quickly.

Another thing. Certainly when I first went there, I was impressed by how lazy most of the people were. After a few weeks, I came to the conclusion that if I had to work on what those people were able to get for food, I wouldn't have produced very much either. It's a sad situation. They really were very fine people on the whole. I am very glad I had the opportunity to be there.

We managed to have a few days before we left to see some of the interesting and historic buildings around Delhi. We saw the famous iron pillar of Delhi. It's essentially wrought iron; I don't think anybody really knows how it was made. Wrought iron is supposed to be resistant to rusting. I examined a fair part of that pillar with a hand lens and I couldn't find a speck of rust anywhere. I understand it was made about 1200 years ago.

As I say, there are several beautiful structures around Delhi. Then we managed to get down to see the Taj Mahal, which as far as I am concerned, has to be the most beautiful building in the world. Not that there aren't many that I haven't seen, but it is absolutely beautiful.

Bombay has some very interesting buildings too. We were in Bombay for a few days because there was one stage at which we didn't know if we were going to be able to find enough bauxite and I went down to examine a deposit a couple of hundreds miles or so south of Bombay. Fortunately, we didn't need that.

Swent: Did you do any development work at all?

Fowler: No. We did lay out the land on which they should apply for operating permits. As I say, they did actually operate some of it, even though they had this other deposit that they got later. But they had to either give up their possibility of leases or else operate. So they did enough operating, shipped out enough, to maintain their leases. I don't know the status of it now.

I think that pretty much covers the situation.

Swent: How did you come home? From Delhi?

Fowler: We came from Delhi. We were in Calcutta; Calcutta was where we sort of finished the job. Or actually Jamshedpur, I guess, because Kaiser still had the construction office there. So we went by train from there to Calcutta and flew to Delhi and spent a few days there. Then I think we went to Bombay and left from Bombay but I don't really remember now. We took a flight home via Beirut; we landed at Beirut. Just before we left, it was doubtful whether we would be able to or not because there was trouble then. That was the time just after Ike [President Dwight D. Eisenhower] had landed a few thousand marines in Beirut and quieted things down instantly.

Swent: When was it?

Fowler: This was December of 1958. Beirut was a beautiful place then. We were able to go out to Baalbek. I had often wondered how people

got so enthusiastic about archaeology. But I sure became an enthusiast in a hurry. What with visiting a few of these things in India and Baalbek, and then a couple of days in Athens and a couple of days in Rome, Geneva, Zurich, Amsterdam, let's see, Brussels, Copenhagen, and London. So it was a pretty rushed tour of all those wonderful cities, but at least we had a couple of days in each of them.

When I went over to India, the whole thing was arranged in very much of a rush, like so many of these jobs are. You have got to get started yesterday. I had to use a little pleading to get permission to spend three or four days in Japan, Hong Kong, and Bangkok on the way there. Anyway, we did. When I had left here, because of the rush to get over, I was talking to Bill Fisher of Kaiser Engineers to whom I reported there and I said, well, I would agree to get going in a hurry, but I would really like to feel that when I get finished that we could come back via Europe. He said, "You would be nuts if you didn't." [Laughter] That was about the extent of my contract. Bill certainly backed me up on it.

From there, I just went over to the travel department in Kaiser and talked to George Lobekke and I said, "I want three tickets around the world, with a stop off for a few months in Calcutta."

"Okay."

Then Ken came over later in the summer.

Swent: That was quite an experience.

Fowler: Yes, it really was. It was great. Then I was back here for a few months and wrote up the final report on it. That report was the evaluation of the reserve needed to justify the investment to build the aluminum plant at Rihand.

Kaiser's Employment and Personnel Policies

Fowler: Then it began to look as if maybe Kaiser was about running out of work. George Gerdes called me up one day while I was still working on the report. George was a retiree from the Corps of Engineers. He had joined Kaiser because of his expertise from working on a number of dams, including, I'm pretty sure, the Grand Coulee and Bonneville. I think he was on several of the dams on the Columbia and perhaps the Hoover Dam.

I had met him in the first place because when he first joined Kaiser, they were interested in some things in British Columbia, power-wise. So Ed Hassan asked me if I had any information on any of the rivers and water potential in British Columbia. I said, yes, I had, because I was, and am, still registered in British Columbia and I got the B.C. Professional Engineer monthly magazine from that. A number of them had had articles about hydro potential. I had kept a bunch of these. Then Ed and George Gerdes and I had lunch together one day and so I made a bunch of these things available to them, which I think was George's first background information on British Columbia.

Well, I saw him occasionally as the years went by. Then, when I first went to India, I was in Calcutta one weekend, and that's a miserable place to spend a weekend alone, so I was stuck in Calcutta, and so was George. We spent the weekend together wandering around Calcutta and out to the park and so on. Incidentally, in the park at Calcutta, there is a banyan tree, one tree, that covers about two acres.

Anyway, as I say, George called me up one day when I was back here and said, "Why don't you come and have lunch with me?" He gave me a copy of a report on the Volta Dam, his preliminary report. He said, "There might be something coming up here. Maybe you should look this thing over and see if it might interest you." I'm still convinced that that would never have happened if George and I hadn't got stuck together in Calcutta for a weekend.
[Laughter]

I didn't know him that well. I had seen so little of him, but you spend a whole couple of days together in a place like Calcutta and you get to know each other quite well.

Two or three weeks later, George called me up again and said that they thought they were going ahead on that project and that Roger Sheridan was with him and Roger was going to be in charge as project manager over there and so why didn't I come over. So the three of us had lunch together.

I don't really remember now whether I was hired for Ghana by George or by Roger, but anyway it turned out that the opportunity was there so I went over to that job, which was in many respects one of the most interesting jobs I was ever on.

Swent: Did Kaiser keep you on the payroll between jobs?

Fowler: Yes, they did, because the interludes were brief enough.

Swent: But then you had to apply for your next assignment?

Fowler: With them? No, I was always on the payroll.

Swent: But you just had to work out a satisfactory arrangement with everybody on your own.

Fowler: Yes, pretty much.

Swent: That's interesting.

Fowler: The job in India was the highest paying one. Of course, Kaiser-- Now, I've forgotten. I was working for Kaiser Engineers Overseas Corporation in India. That was the organization that built the steel plant in Jamshedpur. In Hawaii, I worked for Kaiser Aluminum & Chemical Sales Corporation. I don't know, I guess it was just a little easier for sales to set up the functions for an office in Honolulu than it was to set up Kaiser Aluminum and Chemical Corporation. I don't really know. Anyway, that's what we did there. In Ghana, it was Kaiser Engineers and Constructors Corporation.

Swent: But your years of service and retirement and all these things, it didn't matter which hat you were wearing?

Fowler: No; all that transferred. Well, for instance, Aluminum had, as I recall it, the best retirement thing of any of them.

Swent: They were not all the same?

Fowler: No, they weren't. But when I finally left, I couldn't retain any of that benefit. Well, anyway, I had some benefits, but I had to take it in cash and therefore the accumulation was taxable as income. Shortly after that the government came out with the Keogh Plan. If they had the Keogh at the time, then I could have put that into a Keogh and then I wouldn't have had to pay taxes on it.

Swent: What a shame.

Fowler: Well, it wasn't all that much, but it was several thousand, as I remember it, of accumulated benefits.

Site Investigation, Volta Dam, Ghana

[Interview 3: April 3, 1991]###

Swent: Yesterday we were just leaving for Ghana. What was the date on this?

Fowler: It was May of 1959. I went over there with a group: George P. Havas, Jr., and Roger Sheridan--Roger was the project manager there. The project when I went there was to involve the dam site exploration, and in anticipation of going ahead, the construction of some roads to be able to get heavy equipment into the dam. Pete Filipovich was in charge of the road work. They were going to do a lot of housing, and George was in charge of Kaiser's part in the housing. Kaiser subcontracted out the work but then to supervise it and so on, that was George's job.

Swent: What was your job?

Fowler: I was in charge of site investigation.

Swent: For the dam itself?

Fowler: For the dam, yes. Not the construction, but the site investigation. So there were a number of interesting things about it. A British outfit, Sir William Halcrow and Partners--they were a good consulting engineering firm--they had investigated a site; the river was fairly wide there and it would have been a pretty wide dam, but the thing they liked about it was that there was an island in the middle of it. Anyway, when they got all through, the total cost was uneconomic.

So George Gerdes went over there for Kaiser and selected what became known as the Akosombo site. There the river flowed south, then it took an abrupt bend to the east, and then went on south again. The gorge was a lot narrower there so that the dam was considerably smaller.

But it had a few problems. The most significant problem was that the river there was one hundred feet deep, and there was a hundred feet of sand in the bottom of the river. So one of the first things we had to do was to get samples of that sand in order to determine whether or not the sand could be left in place under the cofferdams. Well, it must have taken us at least six weeks before we got a sample of that because it was practically a quick sand. They had, when I got there, a couple of drills already on the job. I think those drills were owned by the geological survey of Ghana. They had a couple of Englishmen operating them. Those fellows stayed on with our project.

Sampling the River Bottom: A Technological Challenge

Fowler: The thing with that was that we had to devise a means of getting a sample of it, which had to be an "undisturbed" sample. I managed

to work out a technique that was pretty involved. I don't think it's worth going into the details of it because there are so many things that you might do with present-day equipment that we didn't have there.

Swent: I would be interested in knowing briefly how you did it.

Fowler: Well, it takes a bit of memory but I think I can more or less remember. But we didn't achieve this until several weeks after I was there. John Fogarty came over as a soils engineer. We had a couple of barges held in place on the river with cables; John went out and sat on the barge for a few days. But the thing was that you had a casing pipe driven down into the sand. Then you attempted to drive a tool down below the bottom of the pipe into the sand for an undisturbed sample. But as you withdrew the drill rod, its volume was replaced by water, which flowed through the sand and washed sand several feet up inside the casing. The sample tube was about two feet long, but you would always wash loose sand up to about three feet inside the casing pipe.

What we finally did was to start using mud. So we found a place where there was some clay and we had two or three of the Africans sit there for a day, munching clay with their hands and making as thick a mud as they could that would still flow. Then we filled the casing pipe with mud; the casing came up through the barge to maybe three or four feet above river level. By keeping the mud in there and then when we pulled the drill rods out, we would keep pouring mud in and keep the mud level up to three feet above river level. That way, no water came up in the bottom of the pipe as the rods were pulled.

Then, eventually, we got the tool with nothing but mud in it--it would obviously fill with mud as soon as you put it in the casing--and put it down and drove it to the bottom of the casing and then down into the river bottom sand. Then again, as we withdrew the rod with the core tube on it, we kept pouring mud in and kept this up to the top of the casing. It took them several hours to get that one sample. We only got one sample; we never tried for any more. It took John practically a whole day to get that one sample, but he did recover it. So that was how we got a sample. This was a split sample tube so you bring it out and you open it up. Then we photographed it with a little note explaining what it was, what hole number and what depth.

But you could see in that undisturbed sample that there was no fine material to bind it. It was an absolutely uniform sand, almost like a quicksand. As a result of that, the board of consultants made the final decision that it would be essential to remove that sand before building coffer dams. So you had to dig sand out to a depth of two hundred feet below river level. They

brought in two special suction dredges to do that when it came time. I wasn't there, of course, when they did the construction. When they got the cofferdams built and started pumping out the place in between, as I recall the information, there were something like 40,000 gallons a minute that they pumped. They kept on pumping like that for several days and the water didn't go down at all. But they may have modified the outside of the cofferdam by pouring some relatively fine gravel and mud over the outside of it. But after a few days, then by that flow of water seeping through it, it sort of packed itself tight. After that, it was fine.

That was a critically important part of it. I think I should probably give you some figures before we finish, but it was more than 20,000 feet of drilling, some of which was in the river, because we drilled through the sand and down into the bottom to get the nature of the rock along the axis of the dam in particular, and then at various places around the abutments and into a supposed spillway site.

The critical thing that led Gerdes to select that site was that on the east side of the river, there was a ridge about a mile long. There was another little valley behind it that perhaps the river had flowed down eons past. The high point of that little valley was about fifty feet below the level of the top of the dam, so you had to put a second little dam out there. But this mile-long ridge had beautiful quartzite along the top of it.

Locating the Spillway

Fowler: So the plan was to make that an unlined spillway half a mile long and therefore a very shallow spillway. That would make it very much less costly because when you get a spillway forty feet deep or something like that, the strength of the structure you have to build is tremendous and it's very, very costly construction. Anyway, that was the scheme.

After we had been on the job a fairly short time, one of the board of consultants, Barry Cooke--Barry is today a very famous consulting civil engineer in regard to dams. He lives in Marin County and he still travels all over the world. I don't suppose there are too many big dams that have been built that he hasn't been on the site. He had formerly been a PG&E [Pacific Gas and Electric] employee. He sent over a report of two PG&E dams that had had unlined spillways in the granite up in the mountains up here in California. When the spillway went into operation, it cut

out this channel where the spillway was and eroded so much that it washed it down into the river below and flooded the power plant.

When I got that, the first thing I did was calculate approximately the horsepower involved in the flow of the spillway operating at capacity. I came up with somewhere around 5 million horsepower. I thought, boy, that is quite an erosion tool. So I called in one of the site geologists, told him the problem, and I said, "We know there are some hard formations there and some soft formations. Would you calculate, in the spillway valley, how much material, on the basis of our present knowledge, would likely be eroded with the spillway operating at capacity?"

So he went to work and came back a few hours later and he came out with a volume that was larger than the main dam. I reported this to Oakland. Then they decided that we should study this spillway ridge a bit more to see if the geologist knew what he was talking about.

They ordered four trenches to be dug all the way down this ridge that the water would flow down. They were five hundred feet long and they were about six feet wide and six feet deep. They were in fractured rock; we didn't have to blast it; at least very little blasting. So those gave us quite a picture. I photographed those. We had the surveyor put markers every fifty feet and then we measured from those markers. We had a rod that was graduated to show depth in feet. Then we put a little blackboard on that rod that marked how far it was from the axis of the spillway. I photographed every foot of those four trenches, so that showed the complete record. The geologist was Mike Morgans, a Cambridge graduate. I don't think he had a doctor's degree. He was wonderful at that type of work. He made sketches to sort of go with the photographs and showed the complete detail. Everybody that saw them was tremendously impressed by those sketches that Mike made up. That gave a fairly alarming picture.

Then they decided we should sink some shafts in those trenches and dig some adits in them. Those made the same picture when you got down fifty feet below ground. It was still the same type of material. We were debating what could be done about this. One day I was out there looking at one of these trenches when all of a sudden, an idea occurred to me. I got kind of excited about this, so I ran all the way up to the top of the ridge and out to the end of it and looked over the end of the ridge into the river. I thought, well, if we spill the water into the river, then you don't need to worry about what it's going to erode. Then I got John Fogarty and talked to him about it. He thought it was a pretty good idea. We sent in this recommendation that they should change the spillway. Instead of having it go over the side of the ridge, it should go over the end of the ridge, which was pretty

narrow so it meant it had to be a very deep spillway and it would have to be lined all the way down to what is referred to as a flip bucket. The water comes down the spillway and then it rises and flows out, maybe jumps, a couple of hundred feet out into the middle of the river.

Well, Gerdes still didn't like the idea of that much extra cost. Then one day a geologist came over to the site, a geologist from the board of consultants. I don't know what his first name was; we called him Tommy Thompson. Tommy and I went up and looked over all these trenches and so on. Then he sat down on a rock and he said, "Well, Pete, I guess I might as well tell you. I was sent over here to talk you out of that screwy idea of having a spillway at the far end of the ridge. But there's nothing else we can do."

So they changed the thing. Actually, they had to modify what I had suggested because there just wasn't room enough to get a spillway of sufficient capacity. They put one spillway where I suggested and then from the start of that, on one side of it, they angled another one off at about 45 degrees. That would obviously cause some erosion problem, but you could do it; if you operate, you don't always need to open both spillways. Most of the time, they just used the one that flipped into the river.

Informative Adits in the Dam Abutments

Fowler: Then we had to do a lot more site investigation to get more information about the area where those two spillways were going to go. That included a couple of adits driven into there. Much earlier in the program, Gerdes had decided on some adits, one adit into each abutment. So we drove those. I have a tremendously high opinion of Gerdes as a dam engineer--he died several years ago--but I gather that this was something rather unusual in dam site investigation up to that time. When he went into those adits and saw how much was revealed by them, he said, "I'm just going to insist on this any time I have anything to do with another site investigation because it reveals so much information that you can go in and see it just the way it is. You can drill it, but you don't really know."

Swent: This had not been done as a regular practice?

Fowler: Well, that's my impression. I wouldn't say it had never been done, but not to that extent---. These two adits went way back into the abutments. They started from a point downstream of the dam so that you would still be able to enter them after the dam

was constructed and the water was up behind the dam. You could still go into these adits and then back along the direction of the axis and you could observe what seepage there was and so on. It also provided a drainage tunnel under part of the dam which means that your rock can't become saturated with water; saturation with water weakens it. So it was quite an important idea, I think.

Swent: Would the adit itself weaken the dam?

Fowler: No, it's too small to weaken it. So those were unusual things about the site investigation. Then another thing too, George had originally figured on the power plant being built in the area where I eventually recommended the spillway. A bit of preliminary looking at that showed that there was some rather poor formations there. So then one of the design engineers in Oakland came up with the idea that we had better put the power plant on the west bank. But it was quite a steep hill rising on the west bank and to get the water into the power plant, you had to cut a channel into this hard rock on the west bank around behind the west abutment of the dam. That was a place where I had a fairly significant difference with some of the powers that be. To reduce the quantity of excavation they planned to have very steep walls. I complained that I thought that it was too steep on one side because of the formation.

The Importance of Learning from Nature

Fowler: Here I go back to a little bit of education in my boyhood. I still remember one time, and I can still visualize being out fishing with my dad, and we saw a rock formation on Kootenay Lake. This was a cliff, a vertical cliff about two hundred feet high coming out of the lake. Then there was a flattish top and then it dipped down about forty degrees into the lake on the west side. Dad said, "You should bear in mind the stability of natural formations as influenced by the dip." This is what led me to complain about the design of the channel.

The recommendation I made at the time was sort of passed up. Then, when we finally finished up, I wrote a report summarizing the site investigation. Would it be permissible to quote a short paragraph from that?

Swent: Yes; certainly.

Fowler: This was the final paragraph on page 2 of the summary report. "The planned west wall of the intake channel is so steep with respect to the easterly dip of strata that its stability must be

watched very closely during construction and plans made to flatten the slope if necessary."

The board of consultants essentially took a calculated risk and decided that flattening the slope was unnecessary. But after they were well into the construction program, then one day about ninety thousand cubic yards of material fell in off the west bank of the intake channel.

Swent: So you were proved right.

Fowler: Yes. But I've often thought since, and I think that maybe this is an important observation, that my failure in recommending that was that I didn't say, "Look at what nature is telling you," because it was written all over the valley. Vertical cliffs where you had the strata dipping into the cliff and gentle slopes on the other side--it was just all over the place. I had sent in many photographs that showed these things. But never once did I say, "Get these photographs out and look at the natural slopes." I find it hard to believe that the board of consultants could have ignored those natural slopes. I just feel that that's a very important thing that gets overlooked a lot, the failure to use some of what nature tells us.

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Swent: That turned out to be very important.

Fowler: Well, it did. Yes. Fortunately, they had a sharp man in charge of the construction when the time came. He noticed some little rocks falling down off the bank one day. He got the whole crew out and nobody was hurt. The dam that was built was a rock fill with a clay core. That means that--the clay is more or less impervious, but then you have to have a big mass of rock to hold the clay in place. Then you have to have layers of what is referred to as filter material; in other words, sand and fine crushed rock, to prevent the clay from mixing with the larger rock. Anyway, the dam has been there for a long time now and it's still--the last time I talked to Barry Cooke, he said that the dam was settling a bit but really almost exactly as they had calculated it should. So it was a very interesting project to work on.

Relations with the Native People

Swent: How long were you there all told?

Fowler: About twenty months. When I first went there, George Gerdes and Roger Sheridan and I, and I think maybe one or two others, went up to near the dam site to meet the local chief. The chief was referred to as the Omanhini of Akwamoo, Akwamoo being the region. The chief was very cordial. I remembered his saying, "If you ever need some extra men to go to work, let me know and I'll get you some."

Well, after we had been about two months into the program, we got instructions from Oakland for a lot of extra work, both digging test pits and clearing a lot of land. If we cleared all the vegetation off, we could see the geology much better and also they could do aerial photography of the actual ground. So I sent word down one evening to the chief. I said, "We would like to have an extra 150 men tomorrow morning and each morning thereafter for four mornings until we have a total of 600."

The next morning, one of his official helpers came up and he had a list of 150 men. Here were the men, all equipped with machetes, ready to go to work. The next morning the same thing, four days in a row.

Swent: That's amazing, isn't it.

Fowler: It was. It's sort of an interesting example of how, in these African tribal relationships--I never saw any evidence of flaunting of power, but the Omanhini had some power and he could use it. Then, two or three times we had some small contract work done there on the site by local contractors. The one I got to know best was John Yankee.

Swent: Was there any problem in acquiring the site from the local people? Were you taking their corn fields or grazing land?

Fowler: No. There were no fields in the vicinity. In fact, there was almost nobody living there. But before they started flooding, they had to, I guess, move maybe a few thousand people. There certainly was some unhappiness about it. The dry season was such that at times they drew the reservoir down quite a long way. That would mean that people from the fringe might have to go quite a long way to get water when the river went down. They thought that most of the time, the reservoir was big enough at high level to not have to be drawn down very much, but at one stage, maybe fifteen years later, after the dam was finished, they had a drought in much of Africa south of the Sahara where the watershed is. At that time, it drew the level down so low that then you had much less power out of the water and they actually shut the thing down for several months.

I was going to say that a large part of the reason for the dam, or the justification, was that they built an aluminum plant. Kaiser was involved in the ownership of the aluminum plant, or partial ownership, but basically, by treating bauxite to make aluminum, you found something that you could export. Ghana didn't have much in the way of exports. By exporting aluminum, essentially you were exporting energy generated by the dam. So it provided a lot of foreign exchange.

One of the tragedies, to my way of thinking, is that since then, the population has doubled so all the good that was done doesn't probably raise the standard of living much.

Impressions of Kwame Nkrumah

Fowler: Another very interesting thing was Kwame Nkrumah, because Kwame had wonderful leadership ability. He did lead his nation to independence from Britain, first on dominion status for about three years or so and then to republic status. I don't think he gained that much by the last switch. Anyway, we were there on Republic Day, July 1, in 1960. It was very interesting to be there at that stage.

Swent: Did you live in a town of any size?

Fowler: We had an apartment in the town of Tema, which is on the coast. It was a new town built there because they built a breakwater so that they could have a port. When we went there, anything that came in had to be unloaded onto lighters, and there would be half a dozen people paddling each one and paddle them into shore to bring supplies into Accra. Heavy stuff, there was a port at Takoradi about 150 miles or so to the west. Tema was maybe twenty miles east of Accra. That was really a new town. We had staff accommodations at the dam site sixty miles from Tema and spent three nights a week there. Kay and Helen lived in the apartment and I got home Wednesday evening and weekends. We had staff meetings in Tema Saturday mornings.

But you had to build a port with a breakwater so that you could bring in the heavy machinery for the dam, and also construction equipment and so on. But what I was going to say about Nkrumah was that after he had brought his nation so far and--. I think there was no question that he was very, very highly thought of by the majority of the people there. Then he let a mixture of power and communism go to his head and he destroyed himself. He went away on a trip one time, he thought he

was a big shot, and he went on a trip, I think it was to China, and when he tried to come back, they wouldn't let him.

I can't help feeling it was sad because the man had so much leadership capability. Anyway, that was what happened there.

Their principal export before that was cocoa. Another little interesting thing about the history in Ghana. Some years earlier, the British had set up an organization known as the Cocoa Marketing Board. That operated at excellent profit. The profit was accumulated. I really can't remember now the amount of it but I think that the profit set aside when they got dominion status, the British handed them on a silver platter about 200 million pounds sterling. For a nation of 7 million, that's a fairly nice little chunk of money. Some of that went into the dam construction and other related things. I don't know what all it was used for, but I think the corruption hadn't got far then and it really did a lot of good at that time.

Swent: You were there at an interesting time then.

Fowler: Yes, it was. It was a very interesting time. The people of Ghana, a lot of them couldn't speak English, but enough could that you could find a means of communication. They were the friendliest people I have ever met anywhere on earth. It was very, very delightful to be with people like that. They were, I guess, one would say a bit simple, but they were intelligent and they were doing a lot to improve their education. Out in the villages, they had schools. I think the start of the schools was by missionaries. In Accra, there was a university and I think Nkrumah can take credit for getting that started. I don't know how good a university it is, but I think it was significant. There was also one in an interior town; I think it was called Kumasi. They had a fairly good technical school there.

Swent: Did you have any native Ghanaians in technical jobs or just manual labor?

Fowler: Yes, we had. Harry Goodman was our chief surveyor. For a long time he didn't have any whites working with him. Later on, when the work got under a bit more pressure, they had at least one other surveyor, maybe there were two--I don't remember--from the U.S. But Harry had a crew of several black surveyors. I wasn't aware of any problem.

Swent: Was Harry from Ghana?

Fowler: No, Harry was American.

Swent: Were there supervisors who were not American?

Fowler: Yes. For instance, driving the adits, we had black supervisors on that. I remember when we first went there being told that you can't do any physical work; if you do, you lose face with these blacks. Well, when we started driving adits, the crew we had there at the time, they didn't know anything about it, and I had to demonstrate personally how to do it. I know that it didn't do me any harm. I think I had a pretty good reputation by the time I left there.

Swent: What kind of equipment did you have?

Fowler: Well, for driving the adits, we used jacklegs and we had compressors. But we had all hand-mucking. I remember going into an adit one morning and one fellow mucking into a little car. I said to the foreman, "Why is only one man shovelling?"

He said, "Well, sir, they say there isn't enough room for two men to work."

I said, "Addie, I think there's room for two people. Let's you and me try it." Well, I knew darn well that there was no way that I could shovel faster than he could and I could shovel pretty darn fast for a few minutes. We filled up a car, probably the fastest one that was ever filled on the job. We got almost full when the fellow came up, tapped me on the shoulder, took the shovel away, and he decided he could do that too.

There were little things like that all the time. We had up to a dozen--about a dozen would be the maximum number of whites we had on the job. When we had that many, most of those were British. The people doing the geological work were on the geological survey. But they were all part of the crew. It was, generally speaking, very harmonious.

Swent: These people on the geological survey, they were from Ghana, but they were white?

Fowler: They were white, yes, but from England. I think maybe they had some black helpers. I don't remember that now. They probably did. They did the logging of the drill core and that sort of stuff. I think maybe that gives the picture.

Severance from Kaiser

Swent: So then you went back home from there.

Fowler: Yes. Then I worked for a month or so after I got back on finishing up the final report. I had quite a bit of it done while I was still in Ghana. I had a bit of work and I got that almost finished. Then one afternoon the personnel manager came in at about 3:30 and he said, "It's my duty to inform you that this is your last day with Kaiser."

Swent: My word! No more warning than that?

Fowler: No. If you allow it, you can resent it.

Swent: I would think so.

Fowler: I felt there was cause for some resentment, because if I had been with Kaiser another month, I would have had three weeks vacation coming. As it was, I only got two weeks vacation. To justify it, the only job Kaiser Engineers had at that moment that they had made any money on, according to George Gerdes, was the site investigation of the Volta River Dam.

In summary, the development of topographical and geological data required the following:

Diamond Drilling (20 percent in overburden)	21,000 ft.
Adits and cross cuts	2,739 ft.
Shafts and Winzes	235 ft.
Excavation of five trenches each \pm six ft. deep and 600 feet long	
Digging 441 geological test pits	
Digging 1792 borrow material pits and auger holes	
Clearing about 100 acres	
Extensive surveying	

The dam was rock fill at modest size, about 300 feet high.

Oh, there are a couple of things I should say about the dam. It wasn't a very big dam, about 10 million cubic yards. As dams go, the one on the Feather River here, the Oroville Dam, is probably more than five times the volume. But the reservoir capacity was 120 million acre feet. Which is about four times the size of the reservoir behind the Hoover Dam, which is the largest in the United States. The lake size was 3,000 square miles. From the point of view of building a dam, it was a very, very fortunate site to be able to put a dam of 10 million yards and get that enormous volume and enormous lake area. It's very rare. At that time it was the largest artificial lake in the world. I think there's one larger in Quebec now. Anyway, that's an interesting feature of it. That's no credit to me, but it was very interesting.

Then we came back here. You know, in the construction industry, when people finish jobs, well, what do you do? I very quickly made up my mind that if I got mad about it, the only person I could hurt was myself. I ended up with a lot of friends still in Kaiser; I had been there practically ten years. I have many pleasant recollections of it. Perhaps the most significant recollection is of the wonderful degree of optimism and enthusiasm present when Henry J. Kaiser was alive. Numerous people agree with my assessment that the organization started downhill the day the "Old Man" died.

Swent: What about their benefits? Did they have a pension or anything like that?

Fowler: Yes. There was one that was automatic by the company for all Kaiser employees.

Swent: No matter which company they were in.

Fowler: No matter which company you were in, you had that basic thing, which was, as I recall it, handled as a bond investment at low interest rates. Then, Kaiser Aluminum anyway had one which, at one time, when I was there, was invested largely anyway in Kaiser Aluminum stock. That was fairly good at that time. Then you vested 5 percent per year in the basic scheme and 10 percent per year in the Kaiser Aluminum scheme, as I recall it. I don't remember, when I went to Ghana with Kaiser Engineers, what happened on that particular phase.

Anyway, I did get out the part I had vested, but as I think I mentioned, I had to take it all in cash because there wasn't any other way to handle it. That meant it was all taxable at that time, because that was before Keoghs.

Pensions for Engineers

Fowler: A thought on this: there are a great many engineers who, at least until very recently, had never accumulated any worthwhile pensions. I remember doing some work for a while. I wasn't going to discuss this to any extent, but I was in Texas for a little while at the old Texas City tin smelter. I remember talking to an engineer there about this subject. He said that he had made quite a study of it and that the vast majority of people in the chemical industry don't end up with any pension, really.

So many of these pension schemes, you have got to be there maybe two or three years before you are allowed to go on the

pension scheme. Then when you do, your percentage of vesting is fairly small. I can see the logic of increasing pension benefits as your longevity increases, but the fact remains that in the engineering field, anyway, longevity is very unusual. If you had maybe a quite modest vesting, but let it start immediately, and had it so that it all went into an IRA when you're forced to leave for whatever reason, I think it would be a much more fair system and you would have a lot fewer people that end up solely dependent on social security.

In the case of Kaiser, I know several people who lost much of what they had accumulated over quite a few years.

With Mountain Copper, I was a beneficiary of the best pension scheme. It's the only pension I have, as a matter of fact, as an actual pension. That had a weakness in it that you had to be employed six years before you became vested. Fortunately, they didn't close down until I had been there seven years. It's rather mediocre--I get eighty dollars a month, roughly, from that, which goes on as long as either Kay or I live. That was an option. Whether you would take it for one person or both. But that's what it works out.

Swent: It's not very much.

Fowler: It's not very much. But I've been able to accumulate enough to set aside that I feel comfortable with what things are as long as Congress doesn't take it all away by inflation, with the savings and loan disaster, and it's quite likely we'll have a bank one that's just as bad. I really can't conceive how Congress can get themselves out of the box except by either inflation or printing money.

Swent: Which is the same.

Fowler: It's just another form of the same thing. I feel that--to me, it's very sad. I think they have gone in for all sorts of extravagances which, to a large extent, are a matter of spending now and making our grandchildren pay for it, or of destroying the purchasing power of people who have saved.

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Swent: Did you want to say anything about the Kaiser health plan, your health benefits?

Fowler: I can say a little about it because we were on the scheme for a short time. When I was in Oakland, we had the Kaiser health plan.

Swent: What did they do for you when you were in Ghana, for instance, if you had been ill?

Fowler: In Ghana, they switched us to a New York Life plan that essentially paid you for what you needed. Fortunately, I had very good health in Ghana. When I was there, I don't remember now what we paid because it was just taken out of your paycheck to cover it. Payroll deductions are a wonderful way to collect money from people without their realizing the cost. I do remember one thing about the Kaiser scheme in Oakland, that whenever you went to see the doctor, you paid one dollar. I think something like that, to make everybody pay a little something. It keeps them from going there for nothing and running up the costs of the program. I think you have to have something like that. Other than that, I don't think I can say anything that's meaningful about the health plan.

Swent: It was new and kind of controversial at that time.

Fowler: Yes, it was fairly new. It was always satisfactory as far as I was concerned. In effect it was the same as I had had with Cominco. There was emphasis on keeping people well in preference to treating sick people.

VI CHIEF ENGINEER AND RESEARCH DIRECTOR, MOUNTAIN COPPER
COMPANY, 1961-1968

Plant Engineer

Swent: Well, are you ready for Mountain Copper then?

Fowler: Yes, I think so.

Swent: How did you get that job?

Fowler: Well, they had been looking for somebody for quite some time. A friend who was still with Kaiser wrote to me in Ghana and told me that Larry Kett, whom I had met, who was the general manager of Mountain Copper, was looking for somebody. So I wrote to Larry and he responded and said something of what sort of a person they were looking for. Of course, I didn't think it warranted my making a change. I didn't want to leave the Ghanaian job in mid-stream.

Anyway, when I got back here, I went and saw him and I looked for quite a time at various possibilities. I guess I must have spent at least a couple of months looking. So I went and saw Larry and I asked him if the opening was still available and he said, yes, it was. But, as I recall it now, it meant a considerable pay cut and that's why I did a lot of other looking before I took it, but then nothing seemed to come up, so I started with Mountain Copper. So the pay cuts many people are complaining about having to take now are not all that new.

Swent: Where was it?

Fowler: At Martinez. The plant was at a place called Mococo--Mountain Copper Company--they had a little railroad siding there. That was the name of the railroad siding.

Swent: Near Martinez?

Fowler: Yes. Well, then, shortly after I had been there, maybe I had been there two or three months, I became aware of a job in British Columbia in connection with one of the major dams they were getting ready to build there. I went up and looked into that and then came back here. I had an offer of a job. I went to Mountain Copper and told them I had an offer of a job, and so I got a substantial pay raise. It still wasn't what I would consider a high-paying job but it was interesting. The people, in general, were very pleasant. Both our children were at Cal so it enabled us to stay here while the two youngsters were at Cal. That was quite an attractive feature that didn't induce you to do too much to try and find a higher paying job.

I was there for about seven years all told, almost exactly seven years.

Swent: What did the job involve?

Fowler: Well, I was engaged as plant engineer. Incidentally, at that time Mountain Copper had decided that they should, for staff anyway, have applicants go through a psychological exam. So I went through this psychological exam. Then I went out and I saw Claude Vickery, who was the plant manager at the time. He said, "Well, the psychologist had raised some question." I've forgotten what it was. I said, well, my answer was so-and-so. Claude said, "Well, that's what I would think." [Laughter] So I was hired.

Well, Larry Kett was the manager in their office in San Francisco. Bill McClung was the manager of the mine at Redding, which was essentially a pyrite mine. They shipped pyrite to General Chemical and Stauffer, both of whom had acid plants here in the Bay Area. They shipped it on an arrangement that these companies burned the pyrite and got the sulfur out of it and then what's left, which is essentially iron oxide, they delivered to Mococo. That's called pyrite cinder--that's the commercial name of it. That was important because pyrite cinder, being of very low value, gets a low freight rate, which was critical.

Shipping Pyrite Cinder to Cement Plants

Fowler: So they had something over a million tons of pyrite cinder stacked up on the plant site at Martinez.

Swent: How did it get there?

Fowler: By truck from those two plants. I've forgotten where the plants were. I think Stauffer's was in Richmond. Maybe they both were. I don't really know.

Swent: They came from Redding to Richmond?

Fowler: Well, it was shipped from Redding to those plants, yes. By rail.

Swent: By rail. And then by truck to Martinez.

Fowler: Yes. I say by rail. I'm almost sure it was by rail because that's a pretty long haul. When you make Portland cement, you essentially use a mixture of limestone and shale, or clay, which are ground together in the proportions to give you the cement you want. But there has to be a certain amount of iron oxide in it, and the sources in California were all a little deficient in iron. The pyrite cinder at Martinez we shipped to the cement manufacturers, who used it to make up their deficiency in iron oxide. I believe that Mountain Copper provided all the makeup iron for all the cement plants in California at that time, and for some time afterwards.

Swent: I need the date on this. When did you go to work for Mountain Copper?

Fowler: In May of 1961. One exception was the cement plant up at Redding.

Swent: I was just going to say that there was a cement plant there.

Fowler: Yes, but there was a small magnetite deposit on Mountain Copper property, so they supplied magnetite to that one.

Swent: I see. That was the Calaveras plant. [For more information on the cement plant, see James Curry, Sr., Metallurgist for Empire Star Mine and Newmont Exploration: Plant Manager for Calaveras Cement Company, 1956-1975, Regional Oral History Office, University of California, Berkeley, 1990.]

Fowler: Yes. If it wasn't all the cement plants in California, it was almost all. So we loaded this iron oxide, several hundred tons a week into railroad cars.

Swent: Was your plant crushing?

Fowler: No. It was a granular product there. Maybe, say, everything under eight mesh, something like that.

Swent: You took the cinder and just ground it.

Fowler: No, we just shipped it out again.

Swent: You didn't do anything to it.

Fowler: We didn't do anything. Going back a bit, at one time a big pile of it was leached, and they got some copper out of it. Then, in the last few years, when perhaps the last half million tons or so of this stuff was recovered, the cinder that came out was much finer and the processing by both Stauffer and General was at a much higher temperature, because they found that by burning this at a higher temperature, they could increase capacity. I think they got maybe about as much proportion of sulfur, but if they burned it at a higher temperature, then they could make more sulfuric acid with the same plant. The product--then, at that higher temperature, it changed the nature of the copper chemicals, the copper in the cinder, and you couldn't leach it without costly treatment.

Looking for New Products

Fowler: When I first went there, they were building a little plant to roast this with what's called a chlorodizing roast. You put some salt in with it and roast it. Then, I think we ground it after that and then leached it. We were able to get some copper out of it but it didn't turn out to be an economically successful operation.

Also, one of the aims of that project was to make a fairly pure iron oxide that could be used for a weighting material in well-drilling muds. We shipped several tons of material that was tested commercially by somebody down near the well-drilling areas of California. As I recall it, it met all the required tests but you couldn't get the mud people to change. They had been using barite for years. This was a little heavier than barite. That was what we tried to sell it on, but many people resist change. So I think it was because we couldn't get it sold for that, that project failed.

Fairly soon after I went there, maybe a year or two, Bill McClung was transferred from Redding down here. Kett retired and so Bill took over in place of him. The first year I was there, the office was sort of collapsing from old age, and so they built a new office. Then they expanded that, and Bill made his office there at the plant and the sales manager's office was there and so on, instead of having it at San Francisco.

I don't know whose idea it was; it was probably hatched between McClung and Stockman, who was the sales manager, that they

ought to try to expand into areas where they could make additional products that could be sold in essentially the same market, which was very largely an agricultural market.

So that was interesting because we got into quite a few new products there over the years. One of the first things after working on that new plant for the weighting mud, they came up with the idea that they could sell more copper sulfate if they could get it in what was sold as coarse crystal, which I would say was three quarters of an inch to one and a half inch in size. I don't remember exactly. They had some of that. But the way the blue stone crystal was made was to take a solution of copper sulfate essentially saturated at boiling point and put it into tanks. The tanks, as I remember it, were about eight feet by sixteen feet and about three feet deep. Then you put two-by-fours across them and you hung copper rods on those. The crystals would form on those copper rods. They would also form on the walls of the tank and the bottom of the tank.

Increasing Plant Production 40 Percent

Fowler: Shortly after I went there, I sort of have a hunch that they thought that I was sort of a luxury for the place. I've often wondered a bit if maybe they thought they would find a project that I couldn't handle and that might lead me to leave or something. Anyway, my assignment was to develop a new tank that would enable us to get a higher proportion of coarse crystal. Well, I've often remarked that everybody knew that they were doing all that could be done in making coarse crystal and that this was an impossible assignment, but I was so stupid, I didn't know it was impossible. What I did was--I started out making some crystals in beakers to try and see what happened, taking a few measurements down in the plant and watching the process and learning from operators.

Eventually, to make a long story short, after three or four months of working on this, I found one very striking thing. Everybody's aware of convection, that hot material rises. But when you have copper sulfate, the solubility, and therefore the specific gravity of saturated solution, increases very rapidly with temperature. So the stuff would, for one thing, crystallize right on the surface as it cooled. You would see little crystals sort of suspended by surface tension on the surface of the tank. Then they would eventually grow so heavy that they would just settle down to the bottom. So you would get a great accumulation of these fine crystals.

One day, I went down. It was in the fall as I remember it. It was fairly cool and the solution was cool on the surface. What they would do is put the stuff in and leave it there for a week. Then they drained the tank and then they would put in fresh hot solution and leave it for another week. Then they would clean the tank out by hand. Well, one morning I went down and I put my hand in the tank. It was cool and I put it in about a foot deep, and it almost burned me. The thing is that that heavy solution, the part that's got most of the copper in it, is so heavy that it won't come to the surface, so you get sort of a reverse convection.

So then, we tried various things to see if we could cool the stuff at the bottom. But most of the things we tried to do, such as gentle stirring, generated fine crystals. I guess this was in effect largely because, if you stirred it at all, then you brought hot solution to the surface. There, you got this crystallizing effect on the surface again. Then they would sink down to the bottom. You would get this big mass of fine crystals at the bottom.

Well, I tried one experiment that was kind of interesting. Instead of having a two-by-four to hang the rods on, we took a piece of what's called a channel, a structural steel channel. This was about a two-by-four channel that went across the tank. Then we welded some stainless steel tubes on the bottom of it and sealed them on the bottom. Then we filled the channel with water. That would go down to these tubes that were welded on the bottom, also filled. Then you got convection in that pipe so that the hot water would rise and would cool in the channel on top. The copper rods, when you would pull them out, would have crystals--maybe they would grow up to four to six inches in diameter at the top and they would taper down to quite small at the bottom.

Crystals that grew on the stainless tubes were, if anything, a little bigger at the bottom than it was at the top and considerably bigger than those on the copper rods. I felt we could have done quite well with that but the plant superintendent thought it was cumbersome and he didn't like it. We didn't go ahead with that.

But then I got to observing other things and talking to operators and thought of some other things. The chief chemist was Parks Matzinger. The company never paid much attention to him or I think they might have done better. Anyway, he got the feeling that when you have some fairly coarse crystals and then you drain the tank and then everything cools off, and then you flood it again with hot solution, that you probably crack a lot of these crystals by thermal expansion.

Then, to take advantage of that idea, when we were ready to change the solution in the tank, we made a little slot on one side of the tank, maybe a couple of feet long, and just cut the wall of the tank down a little bit. Then we put a trough on the outside of it. The solution could overflow, and then from this trough outside, you could drain it down. You could plug up the drain when you were through. When we changed the solution, instead of cooling off the crystals, we brought the new solution in through a hose and put it down to the bottom of the tank, this being a much heavier solution, and then it displaced the present solution by overflowing it. That stopped the breaking of the crystals by thermal expansion.

At the same time, we switched over from putting in new solution every week to changing it every five days, so that in two weeks, we essentially had three changes of solution instead of two. This was a result of studying the cooling curves and so on. Another thing we did was where these crystals would form on the surface, when we changed the solution, then we just sprayed with a hose so that we put about a quarter of an inch of water over the surface, making that layer too dilute to crystallize.

With those few little changes that came from watching operators and talking to operators and listening to operators and using a little bit of judgment and so on, well, we increased the plant capacity by about 40 percent. There was really virtually no cost to it. So that was a very interesting thing.

Then, as I say, McClung and Stockman came up with the idea that we should try to expand. Because the operation was based on scrap copper--your copper chemicals are pretty expensive because you're starting with an expensive raw material. We thought we could maybe find some new chemicals that we could produce and sell without increasing the sales cost or overhead.

Devising a Machine to Make Zinc Sulfate Cubes##

Fowler: We went into making some zinc sulfate. We tried buying some zinc oxide residue from Pacific State Steel Mills, down here at Niles. A lot of the steel they were making from scrap. It was often galvanized and so you get zinc oxide flue dust. But it had a lot of impurities in it and it just was too expensive at that time to remove the impurities enough to make a decent zinc sulfate. Then we bought zinc oxide fume from the smelter at Selby. With that we were able to make a pretty good grade of zinc sulfate.

When zinc sulfate crystallizes, it tends to crystallize either as a monohydrate or heptahydrate--that's seven waters of crystallization. By heating this stuff you can get a mixture of heptahydrate and monohydrate in a slurry. So it was the equivalent of about four waters of crystallization.

We produced some and we sold it as what we called a tetrahydrate, but technically there isn't any tetrahydrate. But anyway, if you have a hot solution with some of this monohydrate precipitated in it, then it really is a slurry. We ended up buying a stainless steel belt and pouring this stuff on to it, about maybe a couple of millimeters thick. Then, with water sprays under the belt, you cool it off. Then it comes off as a slab two millimeters thick. There was equipment available to crush that, but what was available put it out as essentially pretty much a powder. Stockman had found that if we could make it fairly coarse, we could get a much better market for it.

We had an experimental belt there for a while that we got from the outfit that made them. It was Sandvik; they are a Swedish outfit. Being a stainless steel belt, why, that was kind of natural for them. But we had a bunch of this stuff that we had made on this temporary test belt. I got playing around with it one day. It was very brittle and easy to break. I put some on a piece of rubber and tried a rolling pin on it. I found that the rolling pin would break this into needle-shaped strips. Then by rolling the rolling pin the other way on it, you could make it into cubes. So I thought maybe we could do something with that.

Then, somehow we ran into some problems. One day a young fellow who was working as a lab assistant came out and asked me something about it. I said, "I've kind of given up on that idea."

He said, "Why?" By the time I got through trying to tell him why, I had pretty much talked myself into not giving it up. So, playing around this a bit more, I came to the conclusion that we could make equipment with a roller in it that would roll this and depress it into a rubber belt, being a very short rubber conveyor belt--. Then we had a little thing; it was called a gold roll. Sometimes you had gold that you wanted to reprocess to remove silver from it. You would roll it with this thing to make it very, very thin to better let acid at the silver.

This old gold roll was sitting there and Parks Matzinger had said something about, "Maybe we could use the gold roll." So we got this thing and I think we spread the rolls apart far enough that we could feed a strip of rubber under it. Then I thought, well, if we could make that roll so that instead of being straight, it had a serrated surface--. We took the gold roll apart and took the roll down to the machinist and asked him if he

could machine that to make serrations in it. He said, sure, he could do that. We tried that and found that in one pass, you would get the product out in cubes. In effect, we built a crusher that would do that, designed and built that.

That was one of the things I liked about McClung. He would give you a project and if you came up with some screwy ideas, he was willing to give it a try. That thing worked really remarkably well. I guess it's the only "Bending Roll Crusher" that's ever been made.

Copper Sulfate in Rice Cultivation

Swent: I would guess so. But you had a marketable product.

Fowler: Yes, we did. The zinc sulfate was used on specific agricultural crops--citrus, I believe. We produced and sold quite a bit of it. Other things came along--in the rice business they use copper sulfate to prevent the growth of algae. Rice is seeded by airplane into six inches of water, which gets pretty warm. The rice won't sprout if you get a heavy growth of algae on the water. So they used to put coarse crystal bluestone in gunny sacks where the water came in and it would dissolve out. You would dissolve out an eighty-pound bag of coarse crystal in the inlet stream in the matter of a few hours.

Then they took to trying to fly the bluestone on. One of our products--I've forgotten the size of it--but maybe about rice-sized crystals--. Those, when they hit the pond or the rice paddies, they would settle down immediately. If you went there and looked at the ponds, then you could see these crystals down in the bottom and a little pool of nearly insoluble basic copper sulfate around it. It just sort of sat there.

I'm not sure whose idea it was but we thought maybe we could do better with crystal of a different size. Well, if you use powder, it's damaging to the aircraft. It's corrosive and so they didn't like powder. But then we found that if we could get a crystal of the right size--. We found that if it was minus-35-mesh and plus-65-mesh, when you dropped it in, it would dissolve by the time it got through six inches of water. That was a new size product and it worked out pretty nicely for the rice people.

Swent: It didn't damage the plane?

Fowler: No, because it wasn't that fine. It wasn't dusty.

Devising a Mill for Ferric Sulfate

Fowler: Another product we played around with was ferric sulfate because we had all this pile of cinder there. Stockman had found a market for ferric sulfate. Stauffer made ferric sulfate, but because they were in the acid business and they used some of this pyrite cinder from us, to make it, essentially, they had an excess of acid. The pyrite cinder they had to buy. What their process was, I don't think I ever knew the details of it, but essentially you had a fairly pure ferric sulfate. But theirs tended to have just a slight excess of acid in it making it hygroscopic. So if you flew this stuff on to apply it, it was extremely corrosive.

We played around with making some with the cinder and the acid. I can remember playing around with this stuff in the lab. I had as thick a slurry as I could get. I was gradually adding acid to it and, as is very widely known, when you put concentrated sulfuric acid with water, it generates a lot of heat. So I was stirring this and stirring it, and kept adding a little more acid. It was getting pretty darned hot. Finally, it got hot enough to really start the reaction going and just in an instant, the whole thing reacted, and I had a beaker full of solid stuff.

We thought, well, what can we do to manufacture this? We made up a little rig, a little tiny pug mill sort of thing, in the lab, and we fed stuff in. We eventually found a mixture--just a tiny little bit of water and the acid and powdered iron oxide--that we could get this thing to act almost instantly. Then with the pug mill, you could get little spherical grains. Then we screened that to the desired size, built a pug mill for it, and we put that product out. We recirculated the offsize.

Swent: You were doing mostly chemistry work, then, really, weren't you?

Fowler: Yes, it was. I went there as plant engineer. One time, McClung wanted me to go up to Vancouver to look into some mining project. I said, "Maybe I should have some business cards."

He said, "Yes, I guess you had better."

I said, "What should I put on them?"

He said, "Call it Chief engineer." So I was chief engineer. Then I also became the director of research. It was an interesting combination.

Another thing. As we went along with these copper chemicals--. Incidentally, going back to the ferric sulfate again, the material, because it was in these granules, it wasn't dusty. It was free flowing so we could sell this in competition with Stauffer's because people liked it better and it was much less corrosive because there wasn't any surplus acid, and theirs was hygroscopic because of the excess acid and ours wasn't.

Swent: That must have been very satisfying.

Fowler: Yes, it was. I don't really remember but I think we put out several thousand tons of it over a period of a couple of years. I don't know where it all went in agriculture, but a lot went to rice. Among other things, they found that sometimes something would happen to the rice that they would need ferric sulfate on it.

Filling an Emergency Order: Saving the Rice Crop

Fowler: I remember once I went up to the rice fields for something to do with some copper sulfate. This was on a Memorial Day weekend. I got to the co-op office up there at Richland. As I walked in, the manager said, "Boy, are we glad to see you."

I said, "That's a very nice welcome, but what can I do for you?"

He said, "Well, we need fifteen tons of ferric sulfate today."

I said, "That's a pretty tall order."

The plant was shut down and I knew that the plant superintendent had gone away for the weekend so I called Bus Johnson, the maintenance superintendent, and asked him if he thought he could somehow get some trucks and get a load of ferric sulfate up to us on this holiday weekend.

He said, "I'll go down to the plant and see what I can do." He went down.

The company had a couple of trucks and truckers. They were away on vacation. He got hold of some contract trucker. Then he got Stockman to come out and make out the shipping papers so that it would be a legal load. By the time he got word back to me, they had decided that they needed fifteen tons for this one

project but better give them another ten. So they loaded up twenty-five tons of ferric sulfate on this truck.

What had happened was this fellow had a rice crop starting and it had started to turn yellow. He had got the agricultural adviser, the state adviser, I guess, or maybe county. The adviser had said, "If you don't get ferric sulfate on this crop before the weekend is over, you've lost your crop." There you've got thousands of dollars invested and it's all gone.

So anyway, the trucker had a couple of flat tires on the way up, but he finally got there. They were dual wheels so by going slowly, he could get by without changing it. It was a very fascinating experience. He got up there and they unloaded ten tons at the warehouse. Then I went with him to take him to the fields where they were going to put it on. When we got there, they had two planes sitting there waiting. Inside of five minutes, one of those planes was in the air. In half an hour, the whole fifteen tons was on the field. I could hardly believe it.

Some of these agricultural businesses, they are sure mechanized.

Swent: Well, they had to act right then. They must have been very grateful to you.

Fowler: Well, they were, yes. It was sure an eye-opener to me. Anyway, that was an example of some of these things that Mountain Copper was able to do to make new products that could be sold by the same sales staff. We didn't have to have any more overhead for it.

Chemonite, A Wood Preservative

Fowler: Another couple of things we made: one was Chemonite wood preservative. That was used by one of these outfits down in Alameda that pressure-treated lumber and piles, that sort of stuff. I don't know if they had used it previously but chemonite--that was a trade name--it was a copper ammonium arsenate. What happens is that when you pressure-treat the wood, the pressure and heat make it penetrate--but then, after the heat and pressure are reduced, the ammonia comes out of it. When the ammonia leaves, then the copper arsenate is insoluble, so you get this wood preservative effect. So we built a little plant to make chemonite.

I remember a kind of an interesting little human interest story that went along with that. We had a laborer at the plant by

the name of Al Trapps. He was a Black, a pleasant lad. He had seniority and so every time an operating job came up, which paid a little more, he would apply for it. They had to give him a chance so they would put him on it; then, after a little while, they decided he wasn't satisfactory and they would put somebody else on.

When this chemonite plant started up, Al applied for the job of operator. I think it was just a one-shift operation, quite a small thing, so Al came to me one day. We had written up operating instructions and so on, but he said, "Pete, I would like you to train me on this so I can do it. I really want this job and I would like you to help me."

I said, "Well, Al, I would like to help you all I can but I'm going to tell you something, Al. All the bosses around here think you're lazy. Maybe the boss in the copper plant here sends you over to the machine shop with something, and what you're doing, the job, maybe you get periods when you aren't very busy. Maybe if you've got to go over to the machine shop, when you get back, you happen to know that there's nothing much you have to do. Whenever you're sent over there to take something, get over there, hustle over there, go as fast as you can and take it over there and say, 'Oscar wants this done,' and then get back here in a hurry. But whatever you do, do it as fast as you can."

So a couple of weeks later, Al came to me and he said, "You know, Pete, two or three people have told me what good work I'm doing."

Swent: A little hustle helps.

Fowler: He held that job down and did it all right. Another thing he said a few days later, "Pete, I've been coaching a high school football team at Pittsburg. I told all these kids what you told me. By gosh, those kids are really getting out and hustling now."

Successfully Directing Research

Fowler: There are so many little things like that in human nature that can help. A lot of the things I did in my capacity as chief engineer and director of research--. I had occasion to design quite a few things and everything I designed as it turned out always worked. It was for one reason: because I was always able to talk to the operators, the mechanics, and the foremen. When I did, they always did what they could to make things work or to point out things that needed to be changed in the design. I think that's a

very important part of human relations that an awful lot of engineers, either they just overlook it or they never get a chance to practice it, and it makes a tremendous difference.

Mountain Copper and Stauffer Chemical each had a 50 percent interest in the San Francisco Chemical Company, which owned a 700,000,000-ton reserve of phosphate rock near Montpelier, Idaho. Stauffer wanted to buy Mountain Copper's interest, but Mococo wouldn't sell. So late in 1967 Stauffer bought all the stock of Mountain Copper Company and shut the Martinez plant down early in 1968.

After that I had three other jobs. I was chief metallurgist in the minerals division of Phillips Petroleum Plant, Avon, California; superintendent and administrative manager, Gulf Chemical & Metallurgical Corporation at the Texas City, Texas, Smelter; and partner with Eli Djeddah in the San Francisco office of Bernard Haldane Associates, Professional and Executive Job Counselling. In 1974, I started consulting. That I continue to a small extent today.

My career has included much routine, which I don't think any engineer should expect to escape. Much has required hard work and long hours. I am very grateful for very interesting work, fine friends and associates, and the opportunity for travel. Many engineers, after successful experience as employees, think they can do consulting. Maybe so, but unless they have a retainer from a former employer, it takes a lot of "job hunting" and time to establish a practice.

My practice has included several very interesting assignments, one of which was in Argentina. This afforded an opportunity to visit Iguassu Falls on the Brazilian border. I have seen Yosemite, Niagara, and Victoria Falls, which are magnificent indeed. Iguassu, however, with a series of cataracts pouring into a canyon for about two kilometers on one side and half a kilometer on the other, is incomparable.

Much of my accomplishment would have been impossible without a loving and supportive wife, who uncomplainingly put up with discomfort and long periods of being left alone. We were able to take the family to most places we went, including India for part of the time. Helen was with us in Ghana for one year. Then she went to the University of California at Berkeley and graduated from the San Francisco Medical Center. She is now a pediatric advice nurse with Kaiser in Oakland. She also gives a variety of classes in related subjects, and is co-author of a book, No Fault Parenting, relating to children under age six. She has two college-aged children, Eric and Sonya. Ken has a Ph.D. and a bachelor's in forestry, and a master's in engineering from Cal

Berkeley, plus a forestry master's from Michigan. He currently has his own consulting business in computer applications in Seattle.

The San Francisco Bay Area Engineering Council

Fowler: This group was started years ago, maybe in the thirties, by several of the engineering societies such as AIME, ASCE, and CSPE. The purpose of the council is to do those things that can be done better collectively than by individual societies. The three most important functions are: arranging Engineers Week to publicize engineering; scholarships for high school seniors going into engineering; and career guidance for high school and junior high school students. I served as chairman of career guidance from 1973-1977. I took over as chair from Mike Williams, professor of Chemical Engineering at Cal. Following his lead, we had an engineering representative assigned to each of some 220 high schools. We published an annual directory of our engineers and school contacts, generously sponsored by Sandia Labs. We published a quarterly newsletter, also distributed to all reps, schools, and council member societies. There were about thirty-five engineering society members, and they met monthly (about nine meetings per year--luncheons at the Engineers Club). These still function, but membership has declined and it is difficult to keep up all the activities.

I was chairman of the San Francisco section of AIME in 1970 and currently am chairman of the San Francisco section of MMSA. I have been the AIME delegate to the council for fifteen years.

VII REGISTRATION OF ENGINEERS; THE NATIONAL COUNCIL OF
ENGINEERING EXAMINERS, 1974-1982

Swent: We might want to talk now about your licensing activities.

Fowler: Yes. That was a very interesting experience. The registration of engineers--.

Swent: I guess I should say that rather than licensing, shouldn't I?

Fowler: Yes. In this country as a whole, the current procedure is that a young person with a degree in engineering has to write what is called the fundamentals exam. Then if they pass that, they are given the status of engineer in training. They have to have some experience before they can write the professional exam to get a license to practice. The exams are all administered by the individual states. They all have something in the way of a board of registration, but these vary a bit. The exams at first were all handled by the state, but then as time went on, they tried to achieve uniformity. For that, there was established the National Council of Engineering Examiners.

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Fowler: It is now, instead of the NCEE, it's the NCEES, which includes surveyors. They prepare exams which are almost universal through all the states. I say almost. They may be completely, though I think California has some special exams of their own. When you pass that exam, you're given registration as a professional engineer. Although the NCEES prepares the exams, the exams are administered by the Board of Registration in each individual state. The states have slightly different rules from one to another. But because the exams are largely the same, it makes it much easier to provide reciprocity.

Swent: What has your involvement been with this?

Fowler: In 1968, at the request of NCEE, the AIME [American Institute of Mining, Metallurgical and Petroleum Engineers] started work on a

program to have mining engineering exams prepared by the NCEE. Progress was slow for several years.

Swent: When did you join the AIME?

Fowler: I joined the AIME in 1939, when I was still with COMINCO. I had sent in my application and I remember, when I came back from British Guiana, I was in New York and I stopped in the office there. I saw Ed Robie and I told him I wanted to know whether I should apply for membership as a junior member or as a member. He asked me something about what I was doing. He said, "I think you're much too modest in your interpretation of doing responsible work. You ought to apply for full membership." So I did. That was in the spring of 1939.

As I recall it, AIME asked Ed Frohling, who was the founder of Mountain States Engineering Enterprises in Tucson, to head up the effort. Ed looked around a little bit for some help and Bob Shoemaker told him to get hold of me. There were two or three others who were involved in it for a start. Ed was not a registered engineer as I recall it. Still, he got the thing moving anyway. Then Bill Ahrenholz, Paul Weir Co., Chicago, took over from him in charge of setup. This was in 1975. I attended many NCEE meetings. The first mining/mineral exam was April, 1979.

Swent: Why did they feel a need to register mining engineers?

Fowler: I think the whole philosophy of it is debatable. You can get so many arguments in favor of it and against it. But it started in this country in Wyoming because there had been some land scandals. It was land surveying that brought about the first registration. Registration of engineers in general has gradually spread. In California, many engineers, I would say, are not registered largely because they work in what is called industrial exemption, which means that if you are working for many of these industries you don't have to be registered as long as for anything that has to be signed by a P.E., you are working for somebody who is registered and can sign it.

I personally, while I say it's debatable, am inclined to favor it because I think that it tends to foster personal responsibility for your engineering work. I think it sponsors a degree of professionalism. It certainly has that effect on me; I know it has on a lot of other people. I am still registered in British Columbia. I read something in their magazine just the other day, a little one-page blurb by the president. He was talking about, well, why register if you don't have to. He said, "It's because it's sort of the highest achievement in my profession and I want to have that. You have to subscribe to a

code of ethics. I think that that tends to make one act ethically. It makes you one with a group of people who are registered. The most advanced engineers in the province are all registered. I feel more one with them." I think that sort of thing is part of the feeling of responsibility that goes with being registered. [See appendix for further considerations regarding the registration of professional engineers.]

Developing a Syllabus for the Mining Engineering Examination

Swent: What did your group do?

Fowler: We first developed a syllabus for an exam. That involved a lot of discussions and trying various things. Whatever you did had to be approved by the National Council of Engineering Examiners, which is made up of delegates from each state board of registration and has representatives from all the professional societies. To agree on the syllabus took a lot of beating about the bush. One of the things that I argued for--as far as the public is concerned, a mining engineer works with what Mark Twain defined as "a mine is a hole in the ground, the owner whereof is a liar."

I said, "There are an awful lot of mining engineers doing an awful lot of things that don't even represent holes in the ground, or maybe they're big open pits or there are all sorts of things in the responsibilities they have. Besides that, most mining engineers, at some time in their lives, get involved at least with mineral processing, concentration, and so on. That isn't technically mining engineering. But I think that we ought to change this to be mining/mineral engineering."

It took a lot of talking but we finally got that. One of the arguments that came up early was one that Jack Hoskins, who was the head man at College of Mines, University of Idaho, that you got so many things that come in it, how can you come up with an exam that--. Supposing one is a dredge man, well, you obviously can't make this exam so that you examine the qualifications of a man to be a dredging operator, which of course is true. Maybe you can put a question in, but on the whole the mining profession is extremely broad. A person has got to be able to jump from one thing to another.

Developing the Eight-Hour Examination

Fowler: Basically, we came up with an exam. This was the principles and practice exam of the NCEE when I was working on this, and as far as I know, it still is. You have an eight-hour exam, or it's two four-hour exams, in which you are to answer a total of eight of twenty questions, which means you can have a fairly broad range of questions and a person should be able to find something out of twenty that he can make a reasonable stab at. We came up with about six fairly broad categories of things in which you should have two or three questions of each. It was required that there be one question that related some way to engineering economics. That, at the time, was NCEE policy. You had to answer one question on that. But you did have to answer eight out of twenty questions.

Each question had to be essentially a one-hour question. You had to allow a person time to read over the whole twenty questions and to select some and to do his answering and then to go back and check it. The basic aim as I recall it was that the person, the examinee, should be able to answer the question in about fifty minutes.

Swent: It might not always be "he" nowadays.

Fowler: How right you are. As a matter of fact, quite a high proportion now are women who are answering the exams.

Swent: Excuse me. I sidetracked you.

Fowler: Anyway, the aim was to come up with questions, each of which would require approximately fifty minutes to answer. Because the person who compiles the question and the answer is so familiar with it, he must be able to do it himself in twenty or twenty-five minutes. Once we had the syllabus, which I say was, as I recall it, five or six fields with three or four questions in each, then to come up with these questions is pretty demanding. I was a bit surprised at how difficult it is to develop good questions that meet rather strict criteria.

Among other things, we sent word out to a lot of people who were registered engineers and asked them to send in proposed questions. I was really shocked at the poor quality of some of the questions that came in. I remember one--I haven't the faintest idea of who sent it in--but this was a question that basically dealt with some form of engineering statistics. I did study statistics once, but long after I had graduated; I never was good at it. But this particular question, just by sort of applying a little bit of logic at it, I was able to answer it and

get the right answer in five minutes. An absolutely useless question, but the people who submitted questions were given information on what was supposed to be the basis.

Fortunately, we did have a lot of people who sent in very good questions. It's a tough assignment, it really is. When I wrote the civil exam in California, I--. Well, I've said many times since that in order to pass that exam, I had to improve myself. Any system that requires that of people is good for society. If there's no other argument for registration, I think that is worthwhile.

Some of the people that worked on it--. When we were starting it and going to a few NCEE meetings and so on, the first two or three, I think I was the only one that went to them, except that Ta Li, from Mining Engineering [magazine of Society of Mining Engineers of AIME] staff was there. He was a tremendous help in the program. I don't know if you've ever met him, but he was a real ball of fire. He's of Oriental origin; I have tremendous respect for him.

Then he left AIME and was replaced by Marianne Snedeker, who at the final stage anyway, was manager of publications for AIME. Wonderfully helpful person. She had such a high standard in everything she did. She came to quite a few of those meetings at the National Council office.

I worked on getting NCEE approval and preparing the first several exams a total of eight years. A number of people contributed at intervals. I've already mentioned Ed Frohling, Bill Ahrenholz, Ta Li and Marianne Snedeker. Of the several registered engineers, those I remember as making the most important and reliable contributions were Jack Hoskins, of University of Idaho; William Hustrulid, of the Colorado School of Mines; John McFadyen, from an engineering firm in St. Louis; Lee Rice, a consulting engineer from Denver; Koehler Stout, of Montana Tech; Tony Szwilski, University of Kentucky; and John Von Kaenel, of the NCEE staff.

Swent: I was just thinking, in terms of your own career, you've done everything from chemical research to mechanical engineering, civil engineering, hydraulic engineering, and pretty much everything.

Fowler: I think a good engineering education gives you the background to use some imagination and so on. I remember a young fellow coming to me one time and complaining about the exam he had written. He said, "There weren't enough questions on there in my field." He said, "I had to answer a question on designing a hoist. I don't know anything about hoists."

I said, "Did you pass the exam?"

He said, "Yes."

I said, "Well, you had to use a little ingenuity, didn't you?" [laughter] He seemed to be quite happy after that.

It doesn't matter what brand of engineering you're in, every once in a while you're going to get up against something that you haven't done before. You're going to damn well have to do it whether you like it or not. I think that is a large part of the essence of engineering. In practice, if you lack experience, you may have to seek approval of someone who has training in the special application.

A Complaint about California Registration of Engineers

Fowler: One of the big complaints I have about the setup of California now is that if you take literally what is written in the act, including some of the rules that are applied by the California Board of Registration, in order to do most engineering, if you do it, you can be accused of practicing civil engineering. If you do that without being registered as a civil engineer, you're in violation of the law. I personally think the whole setup is a restraint of trade.

They have in California what they call the practice acts, which are civil, electrical and mechanical. The civil has a very, very broad definition. The others, like metallurgical, are called a title act. I have registration as a metallurgical; I grandfathered into it. I already had metallurgical in Nevada. If you are going to do metallurgical engineering, some time you are going to have to design a tank. I can hardly imagine a metallurgical engineer getting by without ever designing a tank. But if he does that, he's practicing civil engineering.

I have complained about this many times over the years. At one of these hearings one time of the Board of Registration, on-- I've forgotten what the real subject of it was. But I recommended that they ought to switch to registering everybody as professional engineers. Then you can require by the code of ethics or anything else, that nobody practice except within his competence. (There is more effort in this direction in California early in 1992.)

That didn't get anywhere at the time, except it stirred up some controversy and quite a bit of work was done on it one way or another. But if you register by all these disciplines-- Theodore Hoover at Stanford, many years ago, went through the

directory of people registered in electrical engineering, or I guess it was maybe members of the Institute of Electrical Engineers. Anyway, he found there were something over three thousand descriptions of engineering efforts. Where can you possibly draw the line on where you should have new disciplines?

This, as far as I'm concerned, comes back to the National Society of Professional Engineers. I worked with a group of them at one time and coming up further with this idea of registration as professional engineers. Then, going beyond that, if somebody thinks it's necessary, eventually they could add certification in some specialties. One in California, of course, is the structural. I think it is essential that that be a very specialized thing. Structural requires some things that are beyond me. Maybe I could have learned it but I certainly didn't.

Swent: Right now, with earthquake awareness, that is important.

Fowler: Well, that's a vital part of the structural. The structural exam, I'm sure, quite a large proportion of it, is dealing with earthquakes. That's just essential.

But I think, among other things, that so many things get by. Well, for example, things that require stamping by a civil engineer, so many of these things, somebody has a junior person do the work and maybe he's working for you, but you can't possibly supervise all the details of what everybody does under you. Yet you take the responsibility of certifying this drawing as being correct if you approve it. That is why I think that regardless of an engineer at a certain level supervising it, he should demand that the person who is working for him signs it and puts his seal on it.

Just a little example in that connection. A friend, Ed Bennett--he and I did a lot of work together related to NCEE at one time. He was telling me one day that a young fellow working for him got registered. This fellow brought a drawing to him. It was all finished up; it looked pretty. He said, "Would you seal this for me?"

Ed says, "You're the professional engineer. Where's your seal?"

He said, "Well, if you want me to put my seal on it, I had better check it a little more." [laughter] I think that probably is typical of a lot of things. If you make everybody be a professional engineer, and registered, and put his seal on everything he does, he's going to think more seriously about his engineering responsibility.

The Need to Protect Whistle-Blowers

Fowler: If you look also at the number of things that happen, where there are avoidable failures--. Well, the ASCE--Civil Engineers--had a big project a little while ago that resulted from investigation of the failure of a walkway in the Hyatt Regency in Kansas City a number of years ago. I got interested in that project. I went to a meeting in San Francisco where they were discussing this. They had a group of three or four engineers sort of running the thing at the head table.

I said, "What are you planning to do to take proper account of things when somebody blows the whistle?"

A fellow stood up at that head table and said, "You had better not blow the whistle unless you are prepared to quit." I think that's an absolute disgrace.

A thing that came up years later. You remember the failure of--

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Fowler: --the shuttle that blew up with a bunch of people on board?

Swent: The one that had the schoolteacher? Was it called Challenger?

Fowler: Yes. The final conclusion was that the failure was from some O-rings. Well, a fellow working for Thiokol tried to blow the whistle on those O-rings because he didn't believe they were right. And he lost his job. Now, to my way of thinking, that's verging on criminal.

Swent: It really was.

Fowler: Yet--. The civil engineers put out a manual; it's still under revision. There is some mention of blowing the whistle in it. But there isn't anything like enough protection, in my opinion. There was something that came up a while ago in federal law in financial matters where if somebody blows the whistle and it's investigated, he now gets a share of the saving on it or something of that sort. I don't remember the detail of that. But some people are recognizing it.

My recommendation to ASCE was that they ought to, say, not to put it in a binding form, but rather ASCE should recommend that every contractor working on a project establish a policy that if

anyone blows the whistle, the matter should not be resolved to his disadvantage without a peer review.

Swent: Were you able to get any of this into your mining engineering exam, then?

Fowler: No. The subject never came up when we working on the exams.

Swent: There was no ethics component?

Fowler: There's ethics involved, yes. When you apply to write an NCEE exam, you agree to subscribe to the NCEE code of ethics.

Swent: I see. So it's just implicit.

Fowler: It's implicit at least. I think that's a good sidelight on it but I think more needs to be done on that. The annual meeting of ASCE last fall was here in San Francisco. That subject came up for discussion.

Swent: This is ASCE. I was wondering if AIME had done this.

Fowler: You know, I don't really know if AIME has a code of ethics. I assume they have. It's hard to believe that they don't. But I think the whole field needs more of recognition of the responsibility involved in these things.

A Variety of Approaches to Safety

Swent: You have mentioned safety several times, its being so important.

Fowler: Yes, it certainly is. Incidentally, on safety, the chemical process industry has done an absolutely marvelous job on it. You get quite a lot of these big companies, they go millions of man hours without a lost time accident. It's truly remarkable. Certainly a lot of the mining companies--.. Well, mining has improved a great deal in recent years. I think it's continuing to improve but I can remember once--

I was working for COMINCO and during the war, I had occasion to come down to examine some properties of Montana Phosphate Company. A couple of things, one that came up there was that when they were shipping product out, they had a siding on one of the railroads. Three railroad tracks came by there. I've forgotten now which they were, but I think there was the Union Pacific and maybe Northern Pacific, so that one of them had a double-track main line and the other one had a single-track main line, all of

which you had to cross to get to this siding. The superintendent or manager of the plant there told me about this and he said, "I've been trying to get the company to put in a wiggle-tail signal. It just doesn't seem to matter what I say, they don't do anything."

In my report, I described this situation, and I said, "So far, only one truck has been hit, but the driver was not killed." Shelledy had been saying this for years and they hadn't paid any attention, so I just put it in that way. "But the driver was not killed." As if it were of no consequence. And they put in a wiggle-tail signal. [laughter]

After being there, coming back to Trail, I stopped at the Bunker Hill and Sullivan Mine, went through the plant and the mine there. I went through the mine with the safety engineer. I had been used to things in the Sullivan Mine in Kimberley where I thought they really had a pretty good safety program. But to go into the mine, going down about a 45-degree slope was a car that a bunch of men sat on. This car had like a staircase on it and you would sit on a stair and put your feet on the next one below you and you would get a whole bunch of people on there.

Then when the thing started to go down, I sort of put my hand out just to hang onto the hand rail. There wasn't any hand rail there, which sort of shocked me a bit. When we came back out, then that conveyance was off and we rode in the skip because there wasn't much hauling of men there at that time of day. Three or four of us got into the skip and then some fellow got on a sort of a bail up over the end of the skip. He stood up on that thing and held onto the cable. I looked at the safety engineer and said, "My God, do you allow a man to ride up there?"

He said, "Well, that's where the general superintendent rides. What can I do about it?"

Now I don't imagine you'd still have found that sort of thing at the Bunker Hill when it was last running, but it's just an illustration of the variety of safety approaches. I think there are still a lot of places where an awful lot of safety is overlooked more than it should be.

Swent: Well, we hope it's improving.

Fowler: I sure hope so, but there are an awful lot of places still where they may say, "Safety First," but they mean, "Profit First." It's a very difficult thing to overcome.

Certainly you can go to absolute extremes in doing things safely. A key example of these extremes, I think, is in this

matter--. They talk about the danger of asbestos in buildings. They are spending probably, nationwide, billions of dollars to take asbestos out of buildings that probably doesn't have a chance of hurting anybody. So you've got to find a reasonable level of these things. But just because it's a little more costly, I don't think justifies giving up a lot of safety.

You asked about changing jobs. With Cominco, a man who didn't like me was promoted to manager of mines. A Cominco friend put me in touch with his friend, the general manager of Pacific Lime Company of Vancouver, who wanted a general superintendent for the plant at Blubber Bay.

Later, an American whose property in Oregon I had examined for Cominco referred me to Mr. Daman, principal owner of Denver Equipment Company in Denver, where I worked two years. Much of DECO's business was foreign and a major revaluation in foreign exchange brought hard times, so I left in 1950.

I had left an application with Kaiser and joined that firm when they reopened a magnesium plant at Manteca during the Korean War. How I got that job was revealed by a conversation about three years later with the secretary of the corporate personnel manager. I asked her if I really owed my job to her.

"Well, when a call came in from Manteca for a man, I remembered that Mr. Wickhorst thought very highly of you and I sent in your résumé."

My last job with Kaiser was chief site investigator for Ghana's Akosombo Dam on the Volta River. When that job finished, I was in Oakland working on a final report. Kaiser Engineers was doing poorly at the time and I was advised at 3:30 one afternoon that I'd be through at 5 pm.

Mountain Copper kept all staff. In all its history, it missed making payroll twice: once, the day of the San Francisco 1906 earthquake; the other, after the banks closed in the Depression. When Stauffer took over, we had three months warning to look for a job. I had trouble finding the Mococo job because of my age, so when I left seven years later I sought professional advice from Eli Djeddah of Bernard Haldane Associates. Thanks to his help I made the change to Phillips Petroleum with a 35 percent pay increase. Pay at Mountain Copper was low, but it enabled us to live in Oakland while Ken and Helen, who were living on campus, got through Cal.

Swent: Thank you very much for sharing all of these ideas and your experiences. You've had a wonderfully interesting career.

Transcribed and final typed by Christopher DeRosa

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Considerations Regarding the Registration of Professional Engineers

H. S. Pete Fowler

The US Constitution provides for regulation by the states for protecting the public's safety, health, and welfare. Hence, in the eyes of the law of all states today, this is the sole justification for registration of professional engineers. Wyoming was the first state to register professional engineers in 1907, to correct abuses of incompetent or fraudulent practices in surveying and real estate.

Public safety and health are most directly affected by civil, electrical, and mechanical engineering. Other branches of engineering have a profound effect on the public welfare, including investors, and safety and health of employees. No arguments, pro or con, are valid except in relation to the registration laws of various states.

Code of Ethics

Few would argue the desirability of requiring conformance with a code of ethics. A major problem lies in enforcing compliance, since protecting the public demands a high standard of competence, yet assessing competence gets confused with restraint of trade.

Bidding engineering work on price competition can lead to pressure to cut corners on engineering quality, and was therefore discouraged by codes of ethics. The Supreme Court, in a suit against the National Society of Professional Engineers (NSPE), barred any engineering society from such bidding restriction. It has, however, upheld the right of states to impose codes of acceptable practice as part of registration laws. For example, Texas Canon I reads, "The engineer's paramount professional responsibility

"Over the years, discipline registrations have proliferated, especially in California. This greatly complicates the operation of a valid system of examination and registration."

should be the safety, health, and welfare of the general public." Anything less makes the code practically meaningless, but there are potential conflicts of interest in many engineering organizations.

How can conflicts be handled? Any corporation could improve its public image by adopting a policy that each employed PE should, without fear of recrimination, record in writing over his seal any problem or flaw in any design that comes to his attention. The policy should further require that his superior provide him a written reply pointing out that the "flaw" is accepted as requiring correction or as a calculated risk, or overruled as erroneous or as a difference of opinion.

Errors in calculation or judgment are inevitable. Despite this, there are limits to how much time and money should be spent to eliminate them. It is difficult, however, to see any excuse for failure to conscientiously evaluate the opinion of a PE. This may be an impossible ideal, but how else can the profession or the industry have credibility?

The National Council of Engi-

neering Examiners (NCEE) has a code of ethics one presumably subscribes to by signing an application to write a Principles and Practices examination. However, NCEE has none of the power of enforcement that is available through state boards of registration.

Registration Qualifications

Qualifications are set by the laws of the states. In general, they require passage of an eight-hour examination in fundamentals, preferably at graduation, and, later, one in principles and practices. The examinations are compiled and distributed by NCEE. This system provides for a high degree of uniformity and reciprocity. States set the education and experience levels (typically four years after graduation) required by those desiring to write the principles and practices examination.

Examinations

The principles and practices examination calls for answering eight of 20 equal weight questions: one on engineering economics, 19 on engineering. Economics may enter into engineering questions, but only provided the question is not answerable by an economist without engineering training.

In preparing examinations, NCEE strives to use questions that require some judgment and can be more effectively answered by someone with four years experience beyond college. The aim is to assess entry-level professional

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competence, not to exclude all but the most skilled and experienced. Great care is exercised to avoid examinations that constitute restraint of trade.

Preparing questions to meet the foregoing criteria is a difficult and serious responsibility. The help of registered engineers is needed. Questions and answers must be prepared according to NCEE specifications. An incorrect solution by one submitting a question might conceivably result in denying a qualified engineer a license to practice. Too easy a question might allow a license to an incompetent, with resultant danger to the public. These statements may sound simplistic, but many questions have been submitted that show no appreciation of the serious responsibility involved.

NCEE recently had a comprehensive study made of work performed by engineers. The 1981 report is titled "A Task Analysis of Licensed Engineers." A major purpose was to appraise the present system and its examinations as a means of evaluating not the expertise, but entry-level qualifications. Part of the objective was to see how well the system discriminates in selecting entry-level professionals capable of public protection, and rejecting incompetents without being unduly restrictive. Avoiding restraint of trade is essential. Despite initial criticism and controversy, the Task Analysis resulted in a system for evaluating questions and a scoring plan that lead to more discriminating questions.

Registration as PE Or by Disciplines

Over the years, discipline registrations have proliferated, especially in California. This greatly complicates the operation of a valid system of examination and registration. In studying branch titles in the 1930s, Theodore J. Hoover, dean of engineering of Stanford University, found "... 3,753 different titles among those given in the 1931 yearbook of the AIEE."

The Task Analysis used a questionnaire with a list of 257 tasks. Respondents to the survey additionally identified specific technical specialty areas of expertise, that were classified under code numbers 001-703. The resulting data constitute a totally unmanageable catalogue of the engineer-

ing profession with something like 180,000 possible permutations of "tasks" and "technical specialty areas."

A study by a subcommittee of the California Society of Professional Engineers divided engineering into six categories: consultation, investigation, evaluation, planning, design, and supervision of construction quality. The 703 areas outlined in the Task Analysis were evaluated. Some were eliminated as being not strictly professional engineering. The study concluded:

"Even with the elimination process used, there remain 310 professional level technical specialties already identified by the NCEE study. Applying this number to the six tasks listed, there still remain more than 1,800 possible permutations of 'tasks' and 'technical specialty areas.' Although down by a hundredfold from the dimensions of the previous problem, this number of combinations still seems quite unmanageable and the concept of licensing engineers by specialized disciplines seems all the more unworkable.

"The predominant nationwide practice of licensing engineers only as Professional Engineer, without any attempt to certify specialized qualifications, is certainly a much simpler and more workable program to administer. Authority certification may develop eventually, but still needs much more comprehensive study and is less critical for protection of the public than improving the basis for evaluation of qualification and first registration of professional engineers."

NCEE has tried to put limits on acceptability of new branches, but the pressure for more proliferation will continue. Among the problems of branch registration are that management always assigns engineers to tasks where it judges them to be competent, regardless of branch of registration. If a person registered as a mining engineer is transferred to metallurgical work, he cannot use the title engineer applied to his new work without passing a new exam, even if past and new experience give him the competence that the manager perceives.

The person registered as a PE need only make sure that he accepts engineering responsibility within his competence and seeks professional advice for those engineering responsibilities beyond his own competence. At first thought, this may sound compli-

cated, but serious consideration shows many branch situations to be far more so.

Every time a new branch is formed, many "incompetents" are sure to be grandfathered into the profession.

Some claim that all true engineering is a combination of civil, electrical, and mechanical. For a mining engineer working on an open-pit road, truck haulage, trolley assist, pumping, compressed air problems, or ventilation, this is indeed true. The validity of the claim, however, depends in part on definitions used in the "professional engineers" acts of the states.

The claim does not take into account many complex applications of civil, electrical, and mechanical with other disciplines, such as chemical, metallurgical, and nuclear. Here, we may have duties that could be safely performed by someone with appropriate combined background that could not be by one trained in the "big three." It might be argued that any engineer should, with reasonable preparation, be able to pass an examination in civil. However, the difficulty for many in other fields is that this might be viewed as restraint of trade.

NCEE has recently discussed a broad examination for PE that would have questions from all the branches. A system of key words enable exam takers to tell at a glance whether to read a question. A mining engineer should be able to solve a problem on mine ventilation. If all engineering is a combination of the "big three," then surely this should also be a suitable question for a mechanical engineer. A good question on irrigation should be suitable for a civil engineer. The question mix must be such that any state now required by law to register by branch could, until it changes the law, stipulate 20 questions to be answered by any candidate.

There will be numerous objections to the proposed examination scheme, but all that is needed is the willingness to allow the engineering profession to become unified.

For those states that now register by branch and wish to switch, the changeover is easy. Continue to register by branch. On some date, announced in advance, switch to registration of new candidates by examination as PE, with zero grandfathering.

Authority branch registration should be required only where clearly required for protection of

the public, as is now the case for structural in California.

It must be remembered that registration requires only entry-level competence. In no way does it guarantee professional expertise that can be established only by experience and reputation. Retesting for maintenance of registration would involve periodic evaluation of such enormous numbers, as compared to initial entry, that it is probably impractical. States might require applicants for extending registration to certify briefly, as if under oath, what the applicant has done to maintain his professional competence. Some states already do this.

The key to success in the registration as PE lies in practice within one's competence. The danger of suit against one who goes beyond it seems sufficient deterrent. Surely we have to have some faith in the professional ethics of those who have subscribed to the NCEE or state codes. The profession will never be worth much if members are not willing to assist authorities in disciplining when appropriate.

ASCE News, Aug. 1983, says Stephen D. Bechtel Jr. chairman of the National Academy of Engineering, sees danger in the profession becoming more diverse and fragmented as specialization increases. He believes there must be ways to achieve unanimity so the profession can enjoy the recognition given to doctors, lawyers, and scientists.

Probably the best logic in favor of registration as PE is the follow-

ing: The legal basis for registration is protection of the public. Remember the definition by the late William H. Wisely, former executive director of ASCE: "Engineering is the practice of a learned profession in a spirit of service." Surely, this can be done better by a unified profession than by a group of bickering splinter groups each seeking its own interest.

Industrial Exemption

An exemption places a strong limitation on the effectiveness of registration. Montana has removed the exemption. Some of the logic for the exemption is that public liability and financial resources of industrial corporations gives the public more protection than does registration. This may be true, but there are advantages to both corporations and the public by having registration more universal.

An engineer's seal is taken seriously by some people. Most engineers have heard of the multi-million dollar cost of errors and the delay they caused in PG&E's Diablo Canyon nuclear plant. Probably all design features were approved by a high-level PE.

No supervisor, however, can possibly check all the details of work by his subordinates. It is interesting to reflect what might have been gained if everyone working on design of that plant had been registered and required by his employer to sign and seal

all of his work. Do professional engineers seal their work as a matter of routine or do they seal it as an indication of putting their professional reputation on the line? If not the latter, where is the protection of the public?

What Price Survival?

Some would argue that much of the foregoing is impractical idealism. Paul Hawkin's 1983 book, *The Next Economy*, argues that quality of information must replace mass and energy use in our gross national product for the nation to survive. Certainly American engineers and their products have to compete in an increasingly intelligent world.

The engineering profession and industry need to improve their credibility in the eyes of an ever-more skeptical public. A young engineer working on a large project made a suggestion that her boss did not approve. When she demonstrated that it would cut project costs by \$10,000, the boss replied that he could not care less. Small wonder we have a credibility gap.

Profit may be a vital motive, but it will not last long unless client and public satisfaction are recognized as essential to profit. I believe that credibility and client satisfaction must be improved and maintained. This can best be done by a unified group able and willing to be registered as professional engineers, and to practice their learned profession in a spirit of service. ■

Fowler Article Lacks Evidence

To the Editor:

I disagree with H. S. Pete Fowler's article "Considerations Regarding the Registration of Professional Engineers" in the February, 1984 issue. I believe there are arguments that can be made against registration in any form.

The intent of the article appears to be that the government establish and enforce a set of regulations in order to protect the public from unethical engineers. Yet, Mr. Fowler does not present any evidence that licensing does in fact protect people (the Sheraton skywalk in Kansas City) or that government legislators and bureaucrats (Abscam, Watergate) are always capable of recognizing ethical behavior.

Furthermore, there is little evidence that ethical or moral behavior can be enforced by legislation (Prohibition). Even with licensing, Mr. Fowler says that the only practical method of enforcement is the fear of lawsuits if the engineer's work is faulty. This same fear of lawsuits applies to non-registered engineers. The difference is that without registration one does not need to fear having a bureaucrat remove one means of livelihood (suspending a license), an event which does not occur very often despite numerous examples of poor engineering designs.

To approach the topic from another angle, assuming that licensing does serve a useful and necessary purpose, then it would seem that licensing should be by discipline and should require periodic reevaluation to ensure that the engineer remains competent and current. If an individual cannot be trusted to practice engineering initially based on his own concept of his abilities, then it would seem to follow that the public could not trust him to decide on his own when he has the knowledge and experience needed to switch fields.

Mr. Fowler and the NCEE task force he describes brush this aside with the reasoning that there are too many fields in engineering to develop a test for each one. Somehow the university system in the country has managed to combine these numerous fields into a manageable sized group of disciplines and offer courses and degrees in them,

and it would seem that a similar division of the engineering fields could be made for purposes of licensing.

Similarly, if there is a need to license engineers initially so that the public can have some assurance of their competence, then the public could use assurance that an engineer who received his license 30 years ago, or even five in some fields, has remained competent and has kept up with changes in technology in the years since the original license was granted. Presumably Mr. Fowler relies on the engineer's own innate common sense in this area, although he still does not trust him to decide when he can start practicing to begin with.

In regard to Mr. Fowler's comment on the Diablo Canyon plant, one wonders why a PE signed off plans that he could not or did not check, and if this same situation (signing of improperly checked work) would not be likely to occur due to pressures to complete a project even if all engineers were registered. There is no reason a firm cannot or should not now require its employees to be responsible for their work, irrespective of legislation.

Quality of work does not develop simply because one has a license or degree or fears punishment, but is a matter of training, pride, and competition.

Thomas Eyer mann
Metairie, LA

Fowler Defends Position

To the Editor:

Mr. Thomas Eyermann's letter, *MINING ENGINEERING*, June 1984, page 655, indicates that my article "Considerations Regarding the Registration of Professional Engineers" at least raised some controversy. The intent of the article certainly was not to advocate that government establish and enforce regulation; all 50 states passed registration laws long ago. About 1974 SME directors decided that the Society should arrange to have qualifying examinations for mining engineers meet NCEE standards and thus be uniform for all states. I was asked to serve on the committee to make arrangements and also to serve on the Professional Registration Committee. I am the only SME member to serve from the start of the effort, to the completion of preparation of examinations through the first six years they were offered. The article reflects views developed in those eight years.

The original charge of the committee was with respect to mining engineers. I argued against considerable opposition to have the name changed to mining-mineral, which includes some mineral processing. Otherwise a person needing registration in the areas of interest claimed by Mr. Eyermann in the SME Directory would probably have to pass exams in both mining and metallurgy.

Certainly there are arguments against registration, but until Mr. Eyermann succeeds in lobbying our 50 states to

abolish it, I'd like registration to be of maximum benefit with minimal interference to engineering practice. The policy of NCEE, in accord with laws of most states, is that registration indicates that the applicant has demonstrated competence to undertake engineering assignments at the entry level. As experience is gained, one builds a reputation and takes on bigger projects. Registration as a PE rather than by branch can establish entry-level competence and still allow, for example, a mining engineer, whom management deems competent to handle a milling problem, to accept the transfer without violating the law. If a qualified mining engineer who works in California has ever laid out a road, designed a tank, established a tailing dam, or written a report, he has in California law been practicing civil engineering and is in violation of the act unless registered as a civil. These are examples of why I advocate registration as PE rather than by discipline. By comparison, a urologist in California must be registered by the state as an MD. The law does not require certification to practice urology.

Mr. Eyermann accuses me of determining how many branches of engineering there might be. The NCEE task analysis questionnaire was answered by about 200 professionals in each of more than 10 disciplines. The number of tasks referred to is based on the engineering work the respondents said they were performing. If Mr. Eyermann is correct, most of them ap-

pear wrong.

NCEE has been attempting for years and now has brought us close to a uniform standard of qualification common to all states. (There are still variations of law from state to state.) To have all registrations as PE would be a simplification comparable to the registration of doctors as MD. In general, I believe the specializations in medical practice are certified by the profession, not by the state boards. There will always be a few who abuse, but in general a unified profession can better serve the public.

I agree with Mr. Eyermann on the impracticality of enforcing ethical behavior. On the other hand, I have talked to a number of registered engineers who have said that passing the exam required them to improve their skills and also heightened their professional consciousness above and beyond that of graduation. Any system that accomplished that has some merit.

H. S. Fowler, P.E.
Oakland, CA

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Eleanor Herz Swent

Born in Lead, South Dakota, where her father became chief metallurgist for the Homestake Mining Company. Her mother was a high school geology teacher before marriage.

Attended schools in Lead, South Dakota, Dana Hall School, and Wellesley College, Massachusetts. Phi Beta Kappa. M.A. in English, University of Denver. Assistant to the President, Elmira College, New York. Married to Langan Waterman Swent, mining engineer.

Since marriage has lived in Tayoltita, Durango, Mexico; Lead, South Dakota; Grants, New Mexico; Piedmont, California.

Teacher of English as a Second Language to adults in the Oakland, California public schools. Author of an independent oral history project, Newcomers to the East Bay, interviews with Asian refugees and immigrants. Oral historian for the Oakland Neighborhood History Project.

Interviewer, Regional Oral History Office since 1985, specializing in mining history.

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